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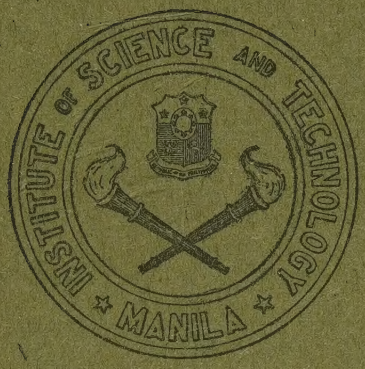

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MEGASPOROGENESIS AND THE DEVELOPMENT OF MEGAGAMETOPHYTE IN ATAMOSCO ROSEA (LINDL.) GREENE *

BY DEMETRIO R. MENDOZA
National Museum, Manila

EIGHT PLATES

INTRODUCTION

Atamosco rosea (Lindl.) Greene, locally known as "Maria de Jacinto," "Sibuyas de Persia," "Sibu-sibuyasan," and "Kulog," is a beautiful tunicated, bulbous, ornamental plant. A native of tropical America, it was introduced into the Philippines during the Spanish regime. The term "Kulog" is applied to it in the Philippines, because the plants flush their flowers usually after the first rain storm.

According to Bailey,[1] the plant is considered in America as the most popular of the rose-flowered species of the genus. It is known as the autumn-blooming rosy flowered species but the members of the genus are generally called *Atamosco, Zephyr, Rain, Fairy,* or *Thunder* lilies.

In the Philippines the plant is propagated by the bulbs. It may also be reproduced by seeds. It grows luxuriantly with little care; thus it has become a favorite ornamental plant. In urban and rural districts, it is used as a border plant to beautify lawns, sidewalks, gardens, and parks.

* Thesis presented in partial fulfillment of the requirements for the degree of Master of Science in Botany, University of Santo Tomas, 1952–53.

[1] Bailey, L. H. Zephyranthes. The Standard Cyclopedia of Horticulture. Popular Ed. 2 (1947) 3541–43.

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Atamosco rosea habitually bursts into bloom en masse from June to October, its flowering season, especially after a heavy rain following a long dry spell, lending gorgeousness and splendor to the scene. At the approach of the dry season from November to January, it flowers less or intermittently and during the dry months not at all, although in a well-tended garden, the plants continue to bloom for a longer period regardless of the rain. In its natural state, a flower at anthesis lasts only for a day or so and wilts.

The study of embryo sac development of the *Atamosco rosea* (Lindl.) Greene has never been undertaken, although Pace [2] described the embryo sac development of another species (*A. texana Herb.*) as of the *Lilium* type. Maheshwari [3] in his critical review of the *Adoxa* type of embryo sac denied its presence in the family Amaryllidaceæ. Rodriguez-Belmonte,[4] on the basis of previous studies, observed that this family has various types of embryo sac development. In view of the variability of the embryo sac development in this family and because of the confused state now found in *Atamosco,* this study has been undertaken in order to determine the exact systematic position and morphological nature of *Atamosco rosea* (Lindl.) Greene.

The cause of the failure of the majority of the ovules to develop seeds has not been properly ascertained up to now. Owing to the inadequacy of our knowledge of this cause, inbreeding and interspecific crossing within the family is a matter of conjecture.

This work, which includes the morphology of the flower, has as its particular object to trace the development of the megagametophyte from the archesporium in *Atamosco rosea* (Lindl.) Greene. In addition, other pertinent information on the identity of this plant from the rest of its variants, on its ovary and ovule development, on pollen, and on the cause of failure of the majority of ovules to develop seeds, will be dealt with in this study.

REVIEW OF LITERATURE

Studies made up to 1900.—According to Maheshwari,[5] the study of floral morphology, especially the tracing of the origin and development of the embryo sac in angiosperm, dates as

[2] Pace, L. Apogamy of *Atamosco.* Bot. Gaz. 56 (1913) 385.

[3] Maheshwari, P. The *Adoxa* type of embryo sac: A critical review. Lloydia 9 (1946) 74–76.

[4] Rodriguez-Belmonte, C. Megasporogenesis of *Polianthes tuberosa* Linn. Philip. Pharm. Asso. Jour. 34 (1947) 331–42.

[5] Maheshwari, P. The angiosperm embryo sac. Bot. Rev. 14 (1948) 1.

far back as the middle of the 19th century when Ameci discovered in 1847 the egg cell in the embryo sac of *Orchis* and Hofmeister diagrammed a few months later the egg-apparatus and the single polar nucleus in Oenotheraceæ. He further said that it took another 40 years of laborious and painstaking researches by noted investigators including Fischer, Jonsson, Strasburger, Vesque, and others, before the true nature of the angiosperm embryo sac was properly determined. But despite numerous studies made on the subject, the terminology remained chaotic and in many cases variation and relationship between the megaspore mother cell and the embryo sac were not properly understood.

Studies made during the 20th century.—At the commencement of the 20th century other workers pursued the investigation further bringing forth comprehensive knowledge of the angiosperm embryo sac and its various developments. The literature on the subject during this period is so extensive that it would be out of place to cite it all in this paper. Coulter and Chamberlain, Schnarf, Soueges, Hakansson, Sv. Murbeck, O. Rosenberg, Juel, Dahlgren, Fagerlind, Stenar, Gustasson, Chiarugi, Carano, Ernst, Wulf and Johnson were among the prominent investigators, cited by Maheshwari,[6] who made outstanding researches in this field. Among the latest important contributions on the subject may be mentioned those of Battaglia,[7] Johansen,[8] and Maheshwari,[9] the last of whom was very prolific in bringing out the tenets and discoveries in this particular field of research.

A few species of Amaryllidaceæ have been studied, but many of the results therefrom cast doubt as to the certainty of the type or types of embryo sac development. Maheshwari[10] cites Schlimbach's report on *Amaryllis belladonna, Buphane disticha,* and *Nerine curvifolia* which should belong to the normal type of embryo sac development instead of to the *Lilium* (*Adoxa*) type; *Crinum asiaticum* which was described by the same author as *Adoxa* type but which was found to be of the *Allium* type when

[6] Maheshwari, P. An Introduction to Embryology of Angiosperms (New York: McGraw-Hill Book Co., Inc., 1950) 23–24.

[7] Battaglia, E. The male and female gametophyte of angiosperm: An interpretation. Phytomorphology 1 (1951) 87–116.

[8] Johansen, Donal A. Plant embryology. A New Series of Plant Science Books 24 (1950) 305 pp.

[9] Maheshawari, P. *Op. cit.*

[10] Maheshwari, P. The *Adoxa* type of embryo sac: A critical review. Lloydia 9 (1946) 102–103.

investigated by Stenar and Tomita. Farrell reported that *Cyrtanthus sanguineus* was of the lily type, and Stiffler also working on *Cyrtanthus parviflorus* supported him as to type of the embryo sac development; but Maheshwari [11] contradicted their finding affirming that both species belong to the normal type. Lastly, Schlimbach and Stenar described *Hæmanthus catharinus* to be of the normal type; on the other hand Woycicki reported the same plant as of the *Adoxa* type; but the investigation of Fagerlind confirmed the first report.

Lately, Rodriguez-Belmonte,[12] working on *Polianthes tuberosa* Linn., described this plant as belonging to the group with normal type of embryo sac development.

As stated above the type of embryo sac development of the genus *Atamosco* has not been definitely established.

Types of embryo sac in angiosperm.—Based on the results of the extensive studies of many workers on the subject, Maheshwari [13] lists the types of the embryo sac development in angiosperm as follows (Plate 1):

1st Type: Monosporic embryo sac
1. 8-Nucleate, Normal or *Polygonum* type
2. 4-Nucleate, *Oenothera* type

2nd Type: Bisporic embryo sac
1. 8-Nucleate, *Allium* type

3rd Type: Tetrasporic embryo sac
1. 4-Nucleate, *Plumbagella* type
2. 8-Nucleate, *Lilium* or *Adoxa* type
3. 8-Nucleate, *Plumbago* type
4. 8-Nucleate, *Fritillaria* type
5. 16-Nucleate, *Peperomia* type
6. 16-Nucleate, *Penæa* type
7. 16-Nucleate, *Drusa* type

The first type originates from one functional megaspore of a tetrad after the first and second meiosis. A total of five nuclear divisions from the megaspore mother cell gives rise to the megagametophyte.

The second is produced from a functional dyad which develops directly into an embryo sac. In this type the functional dyad continues to divide twice from its binucleate stage giving rise to an eight-nucleate megagametophyte. The nonfunctional dyad finally disappears.

[11] *Loc. cit.*

[12] Rodriguez-Belmonte, C. *Op. cit.*

[13] Maheshwari, P. The angiosperm embryo sac. Bot. Rev. 14 (1948) 2–4.

The third is directly derived from the megaspore mother cell. The daughter nuclei after the first and second meiosis never form cross walls. As a result, the four nuclei divide once more to form the eight-nucleate embryo sac. An additional division may result depending on the type of polarity which the nuclei may take during the four-nucleate stage, and on the number of the nuclei in the megagametophyte. Battaglia [14] states that the embryo sac development depends essentially on the situation which exists in the micropylar region. Furthermore, the process of wall formation marks the end of mitosis in the embryo sac.

Maheshwari [15] cites the occurrence of the three main types of embryo sac development in the different families of the angiosperms as follows:

(1) The monosporic type, eight-nucleate embryo sac, constitutes the greater part of the angiosperm. This forms approximately 70 per cent of all the plants already studied. Its occurrence is spread through either dicotyledonous or monocotyledonous plants; (2) the bisporic type, typified by *Allium,* is rather less common. This is the characteristic of the families Podostemonaceæ, Butomaceæ, Alismaceæ, and the Viscoideæ of the Loranthaceæ. It is fairly found in Balanophoraceæ, Liliaceæ, Amaryllidaceæ, and in Orchidaceæ; and (3) the tetrasporic type is typically found among the Liliaceæ, Plumbaginaceæ, Ulmaceæ, Caprifoliaceæ, Penæaceæ, Euphorbiaceæ, Malphighiaceæ, and Combretaceæ.

MATERIALS AND METHODS

Flowers in various stages of development collected from plants found in the City of Manila, Pasay City, and Candaba, Pampanga, were used in this study. The flowers were collected in the morning, at noon, and in the afternoon, from time to time, during the flowering season from June to October.

Young flower buds of different ages, obtained from the bulbs dug from the ground and from flowers at anthesis, were grouped as follows:

First group, flower buds ranging from 3 to 15 mm long; second group, flower buds just emerging from the bulb's neck and shooting out of the soil surface; third group, flower buds whose scapes rose about 5 cm high including those parts where the perianths were still closed but already out of the spathe;

[14] Battaglia, E. *Op. cit.,* p. 97.
[15] Maheshwari, P. *Op. cit.,* 87–124.

fourth group, flowers in anthesis or in bloom including some which showed signs of wilting.

The specimens were prepared by cutting the inferior ovaries transversely into two parts. In the case of the first group one trimming often included the whole ovary and stamens, because of their small sizes. The specimens were immediately fixed in formo-aceto-alcohol and Bouin's fluid. The former was used considerably, because of ease in handling and the beautiful results it gave.

The materials were washed and dehydrated in ethyl alcohol, cleared in xylol, embedded in paraffin, cut in microtome, stained, and mounted in balsam, following Chamberlain's method of paraffin technique. [16]

The ovaries in paraffin were cut transversely to secure the longitudinal sections of the ovule with the aid of a Bausch and Lomb clinical microtome. The sections were prepared in ten and fifteen micra thickness.

A special apparatus for the proper holding and cutting of the specimens was ordered locally in the absence of a suitable one for the purpose. Thinner sections were cut from the young ovaries; thicker ones from the older. Three to four ribbons, approximately 40 mm long or just enough to be covered by a long-sized cover slip, were laid parallel along the length of a slide. Over a hundred slides representing a total of about 2,000 ovules were prepared.

Heidenhain's iron hematoxylin was principally used in staining the sections. In some mounts, orange G dissolved in clove oil was applied as a differential stain. The single and the double stains were satisfactory. But the former was preferred in view of the clarity gained during the stages in megasporogenesis as well as in megagametogenesis. All the specimens were mounted in balsam and covered with 24 by 50 mm cover slip.

As soon as the mounted specimens have dried, they were examined individually under a Bausch and Lomb microscope with magnification of 50 to 645 micra. Photo-micrographs (of 420 micra magnification) were taken of the various stages of megasporogenesis and megagametogenesis up to the binucleate embryo sac (Plate 8, figs. 1–5). Illustrations were drawn by the writer of the materials as seen through a Bausch and Lomb microscope with the aid of a camera lucida attached to it.

[16] Chamberlain, C. L. Methods in Histology (5th ed.; Chicago: University of Chicago Press, 1932) 112–131.

Botanical specimens in fresh condition of *Atamosco rosea* (Lindl.) Greene were compared with the yellow and the white flowered variants.

RESULTS AND DISCUSSION

Several kinds of *Atamosco* "Lilies" in cultivation in the Philippines are presently known, although only *Atamosco rosea* (Lindl.) Greene or the rose flowered species has been reported by Merrill. [17] and [18]

In the Index Kewensis, [19] the following synonyms of *Atamosco rosea* (Lindl.) Greene have been recorded: *Amaryllis rosea* Spreng., *Habranthus versicolor* Herb., *Zephyranthes bifolia* R. Roem., *Z. carnea* D. Dietr., *Z. rosea* Lindl., and *Z. versicolor* Baker. Various authors are divided on the use of the proper generic name. Some authors adopt *Zephyranthes* while others recognize *Atamosco* as a valid name. The writer uses the latter name following Merrill.[20]

The plant (Plate 2, fig. 1) is a low, green herb with subterannean bulb. The bulb is ovoid and tunicated up to 2 cm in diam., short necked. Its surface is covered with a brownish-black membranous sheet which exposes the white bulb upon cleaning. The leaves are few, generally 4 to 6, basal, linear, up to 35 cm long, 4 to 8 mm wide, often arching, thin, and fleshy, rather shiny and somewhat chanelled adaxially, apex obtuse to rounded. The scape is solitary, erect, straight, cylindrical, slightly taller than the leaves, one flowered. The pedicel is 2 to 5 cm long, 2 to 3 mm in diam., green and beyond the spathe. The flower is solitary, dichlamydeous, trimerous (sometimes tetramerous), actinomorphic, bisexual, and epigenous. The perianth is funnel-shaped with segments arranged in two whorls, segments imbricate, rose to light purple, oblong-oblanceolate to oblanceolate, 3 to 4 cm long, 8 to 14 mm wide, the inner three slightly smaller and narrower, apex obtuse to sub-rounded, apiculate. Stamens 6, included, filaments filiform, 1.3 to 1.8 cm long and gradually tapering toward the apex; base adnate to and opposite the perianth segments; anthers yellow, oblong, to linear,

[17] Merrill, E. D. Flora of Manila (Manila: Bureau of Printing, 1912) 147.

[18] Merrill, E. D. An Enumeration of Philippine Flowering Plants (Manila: Bureau of Printing, 1922), I, 210.

[19] Jackson, B. D. Index Kewensis: An Enumeration of the Genera and Species of Flowering Plants 2 (1895) 1249.

[20] Merrill, E. D. *Loc. cit.*

slender, 6 to 8 mm long, directed outward, notched at the base, versatile, dehiscence loculicidal. The ovary is inferior, trilocular, style filiform, 2.0 to 2.4 cm long, inclined, stigma distinctly trifid. The ovules are anatropous, 12 to 18, axillary, two rows in each locule facing outwardly from each other. The fruit is a dry and soft dehiscent capsule, trilobed, slightly compressed, dehiscense loculicidal (Plate 2, figs. 1–9). The seeds are few, 1 to 8 or none at all, black, irregular, and pliable.

White and yellow flowered variants, which are also in cultivation in the Philippines, have, in addition, some morphological characters distinct from the rose-flowered. These variants are included at present under *Atamosco rosea*. The writer believes, however, that because of the existence of these specific morphological differences, these variants should be separated from the species treated in this paper.

The differences between the above is given in the following comparative table:

Organs	Rose flowered *Atamosco*.	Yellow and white flowered.
Leaf	Thin, flat, arching, slightly chanelled.	Very thick almost cylindrical, erect.
Spathe	Distinctly bifid, apex acutely pointed.	Never bifid, apex caudate.
Pedicel	3 to 5 cm long, beyond the spathe.	12 mm or less long, within the spathe.
Perianth segments	Oblong-oblanceolate to oblanceolate, apex apiculate, just shrivel upon wilting.	Elliptic, apex acute, rolling inward upon wilting.
Stamens	Filaments 13 to 18 mm long, anthers slender directed outward.	Filaments 12 mm long or less, anthers robust, directed inward.
Pistil	Style 2 cm or more long, stigma distinctly trifid.	Style 1.2 cm or less, stigma capitate, faintly trilobed.

From the above table it appears that the white and yellow flowered *Atamosco* are related rather to *Zephyranthes candida* Herb. than to *Atamosco rosea* (Lindl.) Greene. They have

the type of stigma by which *Zephyranthes candida* Herb. is separated by Bailey [21] from the majority of the more popular American zephyr lilies.

Development of the flower.—The solitary flower initial arises from the axil of the young leaf scale upon a short stem of the bulb. At first, it is no more than a white speck. As it grows, it develops into a sword-shaped structure. The lower portion below the node holds the handle or the scape; whereas the spathe forms the blade which narrows acutely to a pointed apex.

The incipient floral structure can be easily differentiated from the vegetative branch in that the latter is flat with a rounded tip and without any apparent visible node. The flower bud stays dormant for some time if conditions are unfavorable; otherwise, it grows and the once negligible scape rapidly shoots up pushing the flower bud out of the bulb. Meanwhile, the spathe begins to bulge. Upon reaching a length of about one centimeter it changes its color from a pure white to a yellowish gray with traces of pink foreshadowing the coloration of the anther and the perianth. In 24 hours the scape emerges from the bulb and soon comes out of the ground surface, raising itself to a height of two or more centimeters.

As growth continues, the flower bud forces its way out of the spathe. In another 24 hours, the scape with the bud reaches a height of 8 cm. Anthesis takes place after another 24 hours. By this time the flower reaches a total height of 30 to 40 cm, the pedicel attaining a length of 3 to 5 cm.

Microsporangium and the microspores.—The anther is a four-lobed structure, elongated and with four pollen sacs. The connective is provided with a single collateral vascular bundle supply at the center. The cross section of the anther (Plate 3, fig. 1) at the microspore mother cell stage shows that the wall layers consist of the epidermis, two layers of the endothecium, one middle layer and the tapetum. The locule surrounded by the tapetum cells measures 58 micra in diameter. The cells of the tapetum are generally squarish in form, uninucleate or binucleate, and of the glandular type. The presence of binucleate cells in the tapetum is similarly reported in *Amianthium muscaetoxicum* Walt. by Eunus,[22] in *Polianthes tuberosa* L. by

[21] Bailey, L. H. *Op. Cit.* 2 (1947) 3541–43.

[22] Eunus, A. M. Contribution to the embryology of Liliaceæ, V: Life history of *Amianthium muscætoxicum* Walt. Phytomorphology 1 (1951) 73.

Rodriguez-Belmonte,[23] and in *Stylidium graminifolium* by Subramanyam.[24]

The microspore mother cells consist of a plate of various polygonal-shaped cells which are 5 to 12 in number, each measuring 17 to 23 micra at its longest diameter. The nucleus is 10 micra in diameter. The cells have straight edges and sharp corners and are densely protoplasmic as shown by the distinctly stained large nuclei (Plate 3, fig. 1).

During the formation of the microspores following meiosis (reduction division), the cells of the tapetum break loose from each other and disintegrate to become the nutrient material of the growing spores. The middle layer is crushed by the pressure exerted by the swelling of the pollen grains and later it disappears. The writer was not able to observe the type of cytokinesis of the microspore mother cell.

As the pollen grains mature, the two adjacent sacs become confluent through the breakage of the intervening wall layers, the pollen grains finally dehiscing at a longitudinal slit. This consists of a rupture of the wall junction of the two adjacent lateral sacs.

The pollen grain when young assumes the form of a folded leaf with a large nucleus enclosed in the center (Plate 3, figs. 2–4). It is also described as boat-shaped type of pollen grains. Monocolpate pollen grain which is the characteristic of these pollen grains is common among the monocotyledons, and among the primitive gymnosperms and the primitive dicotyledons.[25]

When the pollen grain develops into its mature stage, it enlarges to a globular form. The mature pollen grain is smooth and ovoid in longitudinal section measuring 34 by 37 micra. It is round in cross section with two nuclei, the larger of which is the tube and the smaller, the generative nucleus (Plate 3, figs. 5–6).

At the time of dehiscence the pollen grains which were collected and allowed to germinate in a drop of water on a slide were observe to puff off rapidly a gelatinous substance which was followed by the protrusion of the pollen tube proving to be longer than the pollen grain itself.

[23] Rodriguez-Belmonte, C. *Op. cit.* p. 336.

[24] Subramanyam, K. A morphological study of *Stylidium graminifolium*. Lloydia 13 (1951) 69.

[25] Wodehouse, R. P. Pollen Grains, Their Structure, Identification, and Significance in Science and Medicine. (1st ed.; New York: MacGraw-Hill Book Co., Inc., 1935) 236.

Megasporophyll.—The ovary is inferior. It is trilocular (sometimes quadrilocular) through the union of the three carpels. The carpels arch inwardly until all their joined edges fuse at the center and become homogeneous forming the axile of the ovary.

The sections of the ovary in different stages (Plate 4, figs. 1–5), show that at the beginning, the three carpels are separated from each other. Later these carpels unite by their edges. Infolding and union are gradual and progressive from the base to the apex. The development of the ovary is similar to that described by Eunus [26] and Murphy [27] respectively in *Amianthium muscaetoxicum* Walt., and *Allium cernuum* Roth.

The style (Plate 2, fig. 3), which is the prolongation of the united carpels, contains three vascular bundles, one from each carpel. It is much longer than the stamens. The stigma is trisected (trifid) and the adaxial surface is provided with numerous papillæ. The surface has the sticky substance which catches the pollen grains that may alight on it.

Megasporangium.—The origin of the ovule and its development is of particular interest. In the cross section of the ovary, it was observed that a star-shaped slit with ends pointing to three directions (Plate 4, figs. 6–10) opens up at the center of the ovary. The slit continues to cut its way until it is nearly halfway through its radius. Then it branches out at the tips and forms a T-figure. Both branches work their way in a curved fashion inward until the primordial ovules are formed. At this stage, the position of the ovule is parietal and each is facing away from each other in the locule. As growth rapidly takes place, the tips of the protruding placenta bearing the ovule initials soon join at the center forming the axile, thus making two rows of ovules in each locule along the axile of the ovary (Plate 4, figs. 9–10).

The primordial ovule at the beginning is homogeneous in character. Later it is differentiated into parts; namely, the crassinucellate nucellus housing the archesporium, the archesporium which enlarges itself from the rest of the nucellar cells and thus becomes the forebear of the embryo sac, the inner integument arising from the base of the nucellus and the following outer integument. Both integuments form like a collar around the nucellus.

[26] Eunus, A. M. *Loc. cit.*

[27] Murphy, J. B. Megasporogenesis and development of embryo sac of *Allium cernuum* Roth. Bot. Gaz. 108 (1940) 130.

The inner integument is swollen at its tip and is composed of two layers of cells. In the mean time that its edge has not fully covered the apex of the nucellus, the lip is sharp and thickened at about three cells from the edge towards the back. The growth of the inner integument is rapid and soon covers the whole apex of the nucellus. This integument continues its growth upward until a teat-like structure is produced by the distinctly swollen lip. At the center of the teat-like structure, the micropyle is formed leading to the nucellar apex.

The outer integument consists of three layers of cells, often more towards the base. It follows the inner integument but never grows beyond the lip of the former. This lip is apparently more depressed and does not take part in the formation of the micropyle.

At its primordial stage the nucellar axis is perpendicular to the funiculus. But due to the rapidity of growth of the ovule on one side, it becomes parallel with the latter. At maturity the micropyle is placed near the funiculus directed towards the placenta. The ovule thus becomes distinctly anatropous.

Inside the nucellar epidermis just below the nose, the archesporium's beginning is just like any other sporogenous cell. Soon it differentiates and becomes conspicuous through rapid enlargement. At first the shape is polygonal measuring 20 micra in diameter and at the same time it is densely protoplasmic. Then it elongates and directly acts as the megaspore mother cell (Plate 5, figs. 1–2 and Plate 8, fig. 1). This type of origin and formation of the archesporium is also found in *Erythronium albidum* by Cooper,[28] in *Fouquieria* by Johansen,[29] in *Allium cernuum* by Murphy,[30] in *Stylidium graminifolium* by Subramanyam,[31] *Cuscuta hyalina* by Tiagi, [32] and in *Ulmus* by Walker.[33] In many other plants already studied, there are cases where an archesporium may divide to form parietal cells

[28] Cooper, D. C. Development of megagametophyte in *Erythronium albidum*. Bot. Gaz., 100 (1939) 866.

[29] Johansen, A. D. Morphology and embryology of Fouquieria. Amer. Jour. Bot. 23 (1936) 96.

[30] Murphy, J. B. *Op cit.* pp. 130–132.

[31] Subramanyam, K. *Op. cit.* p. 71.

[32] Tiagi, B. A contribution to the morphology and embroyology of *Cuscuta hyalina* Roth. and C. *planiforme*. Phytomorphology 1 (1951) 12–14.

[33] Walker, R. I. Megasporogenesis and development of megagametophyte in *Ulmus*. Amer. Jour. Bot. 37 (1950) 47.

or it may function directly as a megaspore mother cell in the same species.

Megasporogenesis.—The writer found that there is a single megaspore mother cell measuring from 37 to 45 micra long and from 20 to 22 micra in diameter in each ovule which is very conspicuous, spindle-shaped (at times cylindric) erect and with both ends blunt. Its apex directly abuts the micropylar epidermis while the lateral side is cushioned by a layer of cells which becomes two to three layers toward the base. The nucleus is large, 17 to 20 micra in diameter, distinct, and located at the center of the cell. The protoplasm is very dense and without any sign of vacuolation (Plate 5, fig. 2 and Plate 8, fig. 1).

The cell undergoes the usual two meiotic divisions (Plate 5, figs. 3–6). The micropylar dyad cell takes up stain heavily so that there is no visible differentiation. It appears blurred and bluish-black in the hematoxylin stain. It does not proceed to the second meiotic division as it degenerates and disappears during the growth of the embryo sac.

The chalazal dyad, however, with its very dense protoplasm is clear and well differentiated in the stain. It takes the second meiotic division (Plate 5, fig. 5 and Plate 8, fig. 3).

In this last meiosis, the micropylar daughter cell, now a megaspore, is lens-shaped and like the micropylar degenerating dyad absorbs stain so deeply that its parts are beyond recognition. A linear triad is formed out of the three cells which are the offspring of the megaspore mother cell. The chalazal cell which shows all parts clearly under the hematoxylin stain becomes the functional megaspore (Plate 5, figs. 5–6 and Plate 8, fig. 3). This result is entirely in contradiction with the finding in *Atamosco texana* Herb. by Pace [34] where she inferred the following:

> There is no evidence that permanent walls came in at the division of the mother cell. The two-nucleate sac (fig. 5) never show any evidence of the disintegrating megaspores, so it belongs to the *Lilium* type described by Coulter and Chamberlain (5, p. 73), in which these two nuclei are the daughter nuclei without separating wall, and the nuclei of the four-nucleate sac are the four megaspore nuclei without separating walls.

With the above inference Pace missed to observe the first and second meiotic divisions of the megaspore mother cell when she admitted that "The division of the mother cell has not been seen." Apparently her observation of the two and four-nucleate embryo sac must have been derived from a functional megaspore and not directly from the megaspore mother cell.

[34] Pace, L. *Loc. cit.*

Upon enlargement of the chalazal megaspore the two blurred cells are pushed upward against the nucellar epidermis at its apex until crushed. They disintegrate and finally disappear. The residues may still be recognized even at the late bi-nucleate stage of the embryo sac (Plate 6, fig. 2 and Plate 8, fig. 5). This type of megaspore formation is occasionally produced in *Polianthes tuberosa* Linn. as described by Rodriguez-Belmonte,[35] in *Musa errans* (Blanco) Teodoro var. *butuan* Teodoro by Juliano and Alcala, [36] in *Amianthium muscætoxicum* Walt. by Eunus,[37] and in *Cuscuta hyalina* by Tiagi.[38] It also falls under Rutgers [39] classification type B, Fig. 33.

Megagametogenesis and the megagametophyte development.— The chalazal megaspore after undergoing appreciable enlargement with its large nucleus located at the center prepares itself for a series of mitotic divisions. This functional megaspore becomes slipper-shaped, a little broad at the apex and tapering gradually towards the base which now measures 28 by 71 micra, its nucleus being 15 micra in diameter (Plate 6, fig. 1 and Plate 8, fig. 4). The two degenerating cells of the triads are still visible and tightly pressed by the growing sac against the nucellar epidermis. The appearance of incipient vacuoles started even prior to the last meiosis which became very apparent during the uni-nucleate stage of the embryo sac. After the first mitotic division, the daughter nuclei are polarized, that is, each nucleus migrates towards the opposite poles leaving a large vacuole at the center of the embryo sac (Plate 6, fig. 2 and Plate 8, fig. 5).

The embryo sac is transformed into an egg-shaped structure. The micropylar side enlarges considerably becoming almost twice as large as before. The cytoplasm decreases considerably in density due to the appearance of numerous and large vacuoles. The cell lining the lateral side begins to be crushed against the nucellar epidermis.

Meanwhile, the cell of the nucellar epidermis at the micropylar side becomes large and massive, thinning out toward the base. Both nuclei at opposite poles take the second mitotic division thus forming a tetranucleate embryo sac with two nuclei at each

[35] Rodriguez-Belmonte, C. *Op. cit.* pp. 33–34.

[36] Juliano, J. B., and P. B. Alcala. Floral morphology of *Musa errans* (Blanco) Teodoro var. *butuan* Teodoro. Philip. Agric. 22 (1933) 98–99.

[37] Eunus, A. M. *Op. cit.* pp. 75–76.

[38] Tiagi, B. *Loc. cit.*

[39] Rutgers, F. L. Reliquiæ Treubiana, III: Embryo sac and embryo of *Moringa oleifera*. The female gametophyte angiosperms. Jard. Bot. Ann. 33 (1923) 24–45.

pole. At this stage the inner integument begins to close the nucellus at its apex, while the outer one closely follows. The inner integument alone covers the nucellus.

All the nuclei at opposite poles take the third and last division to produce the typical megagametophyte or the eight-nucleate embryo sac. All the nuclei are practically of the same size and shape while the quartet are still at opposite poles and each bears a distinct nucleus. At the 4-nucleate stage, the embryo sac measures 50 by 115 micra, and each nucleus having 14 micra in diameter.

The usual process in the organization of an eight-nucleate embryo sac prevails. Of the four nuclei at the chalazal end, the three, which do not form cell walls, become antipodals while the last nucleus migrates towards the center, meeting the other from the micropylar quartet. The polar nuclei upon contact fuse together before fertilization and become the secondary nucleus. The three remaining nuclei of the micropylar quartet form the egg-apparatus.

Of the three micropylar nuclei, one of these enlarges and places itself between the other two to become the egg cell and the latter as the synergids. The egg cell is upright, broad on top and tapering toward its base which measures 17 by 34 micra. Its nucleus measures 15 micra in diameter, which is close to the apex and the vacuole nearer the base of the cell (Plate 7, fig. 2). The two synergids which are lying laterally and closely at the base of the egg cell are pressed against the nucellar epidermis. The nucleus of either cell is nearer its base and the vacuole on top. The egg and the synergids are attached to the micropylar end of the embryo sac. This organization of the egg-apparatus with the corresponding location of the nucleus and vacuole in the cell is of a general occurrence in many plants. There is, however no filiform apparatus observed on the bases of both synergids, which structure was found present in *Atamosco texana* Herb. by Pace.[40]

The polar nuclei which come in contact at the center of the embryo sac apparently enlarge themselves faster than from where they originate. The polar nuclei before fusion measure from 14 to 17 micra, but after the fusion, the resulting nucleus is from 20 to 27 micra (Plate 7, figs. 1 and 3).

From the foregoing observed actions, it can be concluded that the type of embryo sac development in *Atamosco rosea* is of the

[40] Pace, L. *Op. cit.* p. 378.

Normal or *Polygonum* type, as generally occurs among the angiosperms.

Degeneration of the egg-apparatus.—In the organization of the embryo sac during megagametogenesis, in the majority of cases the egg and its synergids fail to organize and develop into cells preparatory to fertilization. The nuclei of the micropylar end, after the polar nuclei have migrated to the center, become disorganized and disintegrated. Finally, they disappear. The disorganized nuclei absorb stain so readily and deeply that they are changed beyond recognition (Plate 7, fig. 3). They have not enlarged at all. On the other hand, the nuclei coming from either pole, that have migrated toward the center to become the secondary nucleus after fusion, enlarged greatly and absorbed stain clearly (Plate 7, figs. 1 and 3).

Of the hundreds of ovaries prepared, the great majority of the ovules failed to develop into the mature egg-apparatus. But the polar nuclei and the secondary nucleus were generally clear and well developed. The failure in the development of seeds due to the lack of fertilization may be traced to the degeneration of the egg-apparatus (Plate 7, fig. 3) consequently, no embryo is formed.

Of the 14 to 18 ovules present in each locule, only as few as four become seeds. The rest are nothing but chaffs. Oftentimes many of the fruits are seedless.

Another cause of failure of seed production is the unfavorable relative position of the stigma to the anthers. In their normal position, the anthers are much below the stigma causing a great disadvantage in natural pollination. Since insects are the main agents of pollination as has been observed during anthesis, their scarcity, therefore, may prevent pollination of many of the flowers. However, since the stigma is receptive to pollination and since some of the ovules produce fertile eggs, it may, therefore, be safe to state that *Atamosco rosea* (Lindl.) Greene will respond to hybridization if the proper technique is applied. This, of course, needs trials to ascertain its possibilities.

SUMMARY

1. *Atamosco rosea* (Lindl.) Greene is a distinct species from the yellow and the white flowered variants also found in cultivation in the Philippines, as revealed by both vegetative and floral differences.

2. Its embryo sac development is of the monosporic 8-nucleate megagametophyte known as the normal or the *Polygonum* type.

3. The archesporium originates hypodermally and develops directly into a megaspore mother cell.

4. The micropylar dyad does not undergo a second meiotic division due to its early degeneration; hence the appearance of a linear triads after the second meiosis of the chalazal dyad.

5. The chalazal megaspore becomes the functional cell.

6. The polar nuclei and the secondary nucleus are very much larger and better developed than their companion nuclei in the quartet, except for the well-developed egg-apparatus.

7. In the majority of cases, the egg-apparatus fails to develop to maturity causing failures in fertilization and turning the ovules into chaffs.

8. The tapetal cells of the microsporangium are of the glandular type containing one or two nuclei.

9. The axile of the ovary is the structure obtained from the mergence of all edges of the three carpels after union.

ILLUSTRATIONS

Plate 1

(Schematic presentation of the various types of embryo sac development)

Plate 2

Fig. 1. Whole plant, × 1/3

2. Perianth opened showing position and attachment of stamens, × 2/3
3. Pistil, × 4/3
4. Longitudinal section of ovary showing position of ovules, × 5.3
5. A carpel stripped of ovary wall showing arrangement of ovules, × 5.3
6. Top view of a four carpellate fruit, × 3.3
7. Side view of a four carpellate fruit, × 3.3
8. Top view of a tricarpellate fruit, × 3.3
9. Side view of a tricarpellate fruit, × 3.3

Plate 3

Fig. 1. Cross section of a young anther, × 215. *e*, epidermis; *end*, endothecium; *ml*, middle layer; *smc*, microspore mother cell; *tc*, tapetal cells.

2. End view of a young pollen grain, × 215
3. Front view of a young pollen grain, × 215
4. Side view of a young pollen grain, × 215
5. Longitudinal section of a mature pollen grain, × 215. *gn*, germ nucleus; *tn*, tube nucleus
6. Cross section of a mature pollen grain, × 215. *tn*, tube nucleus

Plate 4

Fig. 1. Cross section of a young flower bud, × 20. *a*, anther; *c*, carpel; *ps*, pollen sac

2–3. Separate carpels before union, × 20

4–5. Three carpels united forming the ovary, × 20

6–10. Stages in the formation of ovules, × 20. *l*, locule; *oi*, ovule initial; *vb*, vascular bundle

Plate 5

Fig. 1. Young ovule showing archesporium marked *a*, × 320

2. Ovule with megaspore mother cell, × 320. *ii*, inner integument; *n*, nucellus; *oi*, outer integument

3–6. Stages in megasporogenesis, × 320

PLATE 6

FIGS. 1–4. Stages in embryo sac development (megagametogenesis) up to 8-nucleate stage, × 320. *dd*, degenerating dyad; *dm*, degenerating megaspore; *ddm*, degenarating dyad and megaspore crushed against the nucellar cells; *es*, embryo sac.

FIG. 4. Eight-nucleate embryo sac. The nuclei are equally divided at opposite poles, × 320

PLATE 7

FIG. 1. Organization of nuclei in the 8-nucleate embryo sac, × 320. Two polar nuclei have not yet fused. *an*, antipodal nucleus; *cpn*, chalazal polar nucleus; *sn*, synergid nucleus.

2. The egg-apparatus, × 320. *e*, egg; *n*, nucleus; *nc*, nucellar cells; *s*, synergid; *vac*, vacuole.
3. Large secondary nucleus (*sn*), antipodal nucleus (*a*) and the egg-apparatus, degenerating, × 320. *e*, egg; *s*, synergid.

PLATE 8

1. Photomicrograph of megaspore mother cell, × 420
2. Photomicrograph of dyads resulting from the first meiosis, × 420
3. Photomicrograph of triads resulting from the second meiosis, × 420
4. Photomicrograph of a uni-nucleate embryo sac, × 420. Two degenerating cells (dyad and megaspore) are still visible at the micropylar end.
5. Photomicrograph of a binucleate embryo sac, × 420. Note the remnant of the degenerating cells at the micropylar end.

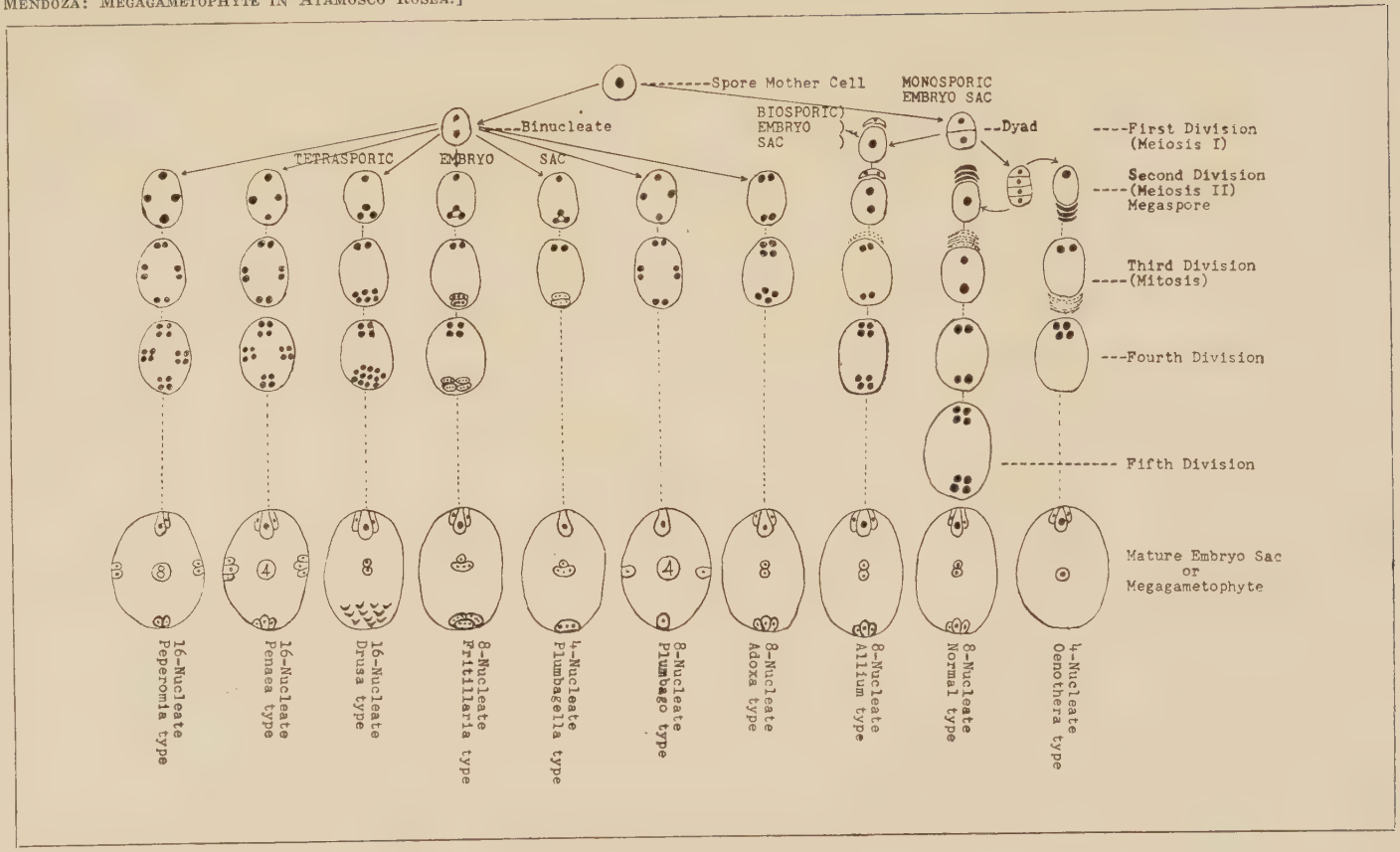

Spore Mother Cell
MONOSPORIC EMBRYO SAC
BIOSPORIC EMBRYO SAC
Binucleate
Dyad
TETRASPORIC EMBRYO SAC
First Division (Meiosis I)
Second Division (Meiosis II)
Megaspore
Third Division (Mitosis)
Fourth Division
Fifth Division
Mature Embryo Sac or Megagametophyte
16-Nucleate Peperomia type
16-Nucleate Penaea type
16-Nucleate Drusa type
8-Nucleate Fritillaria type
4-Nucleate Plumbagella type
8-Nucleate Plumbago type
8-Nucleate Adoxa type
8-Nucleate Allium type
8-Nucleate Normal type
4-Nucleate Oenothera type

PLATE I.

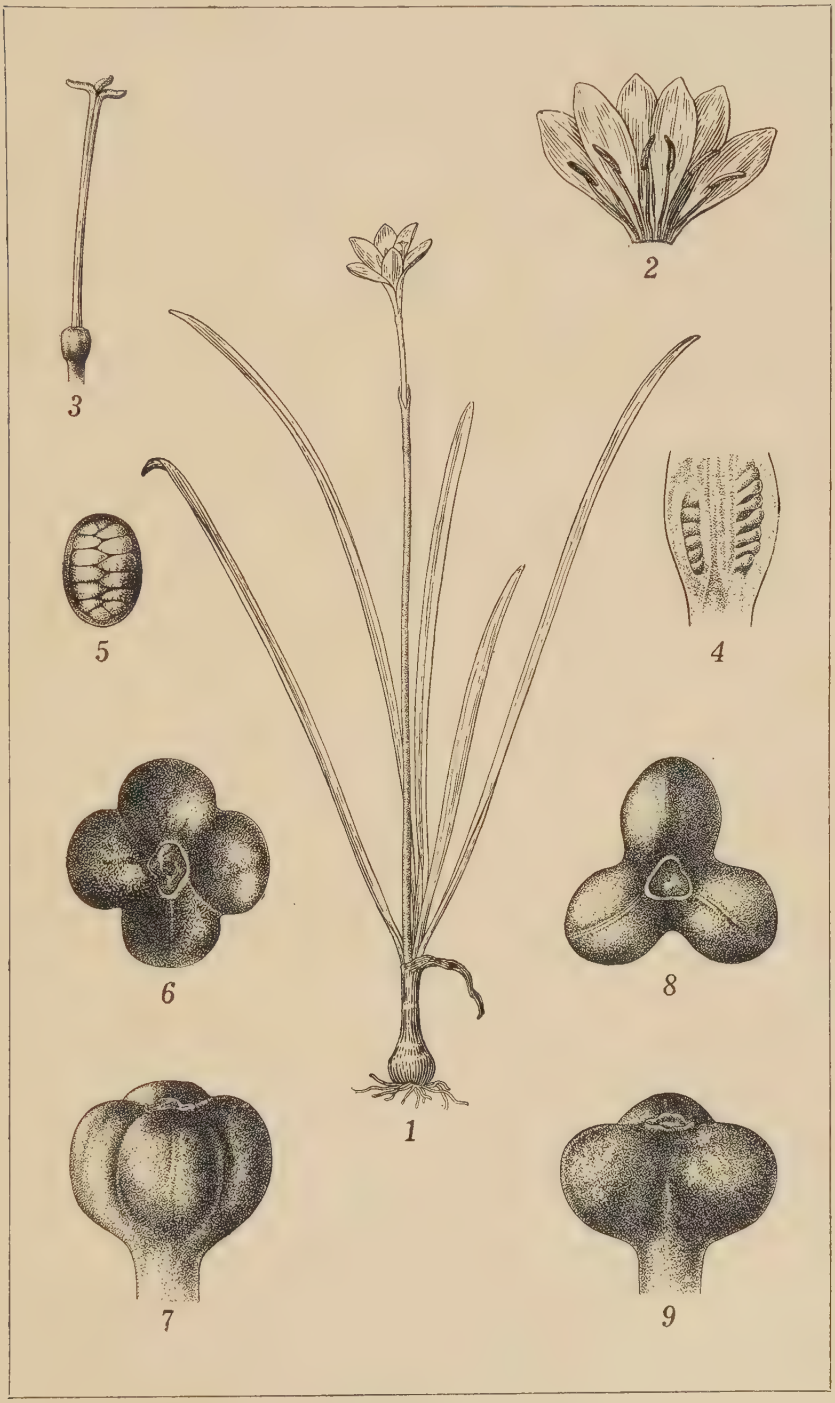


PLATE 2.

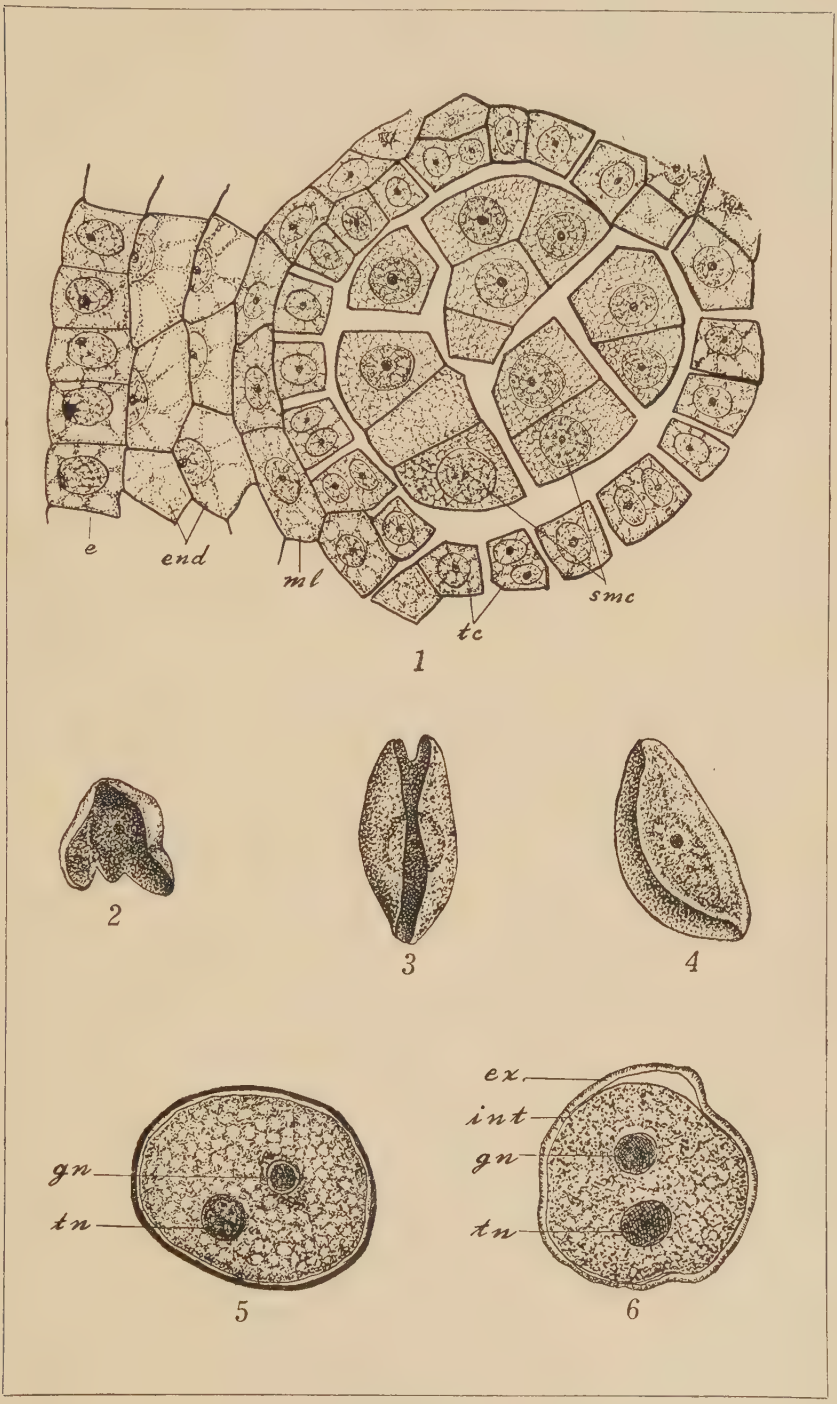
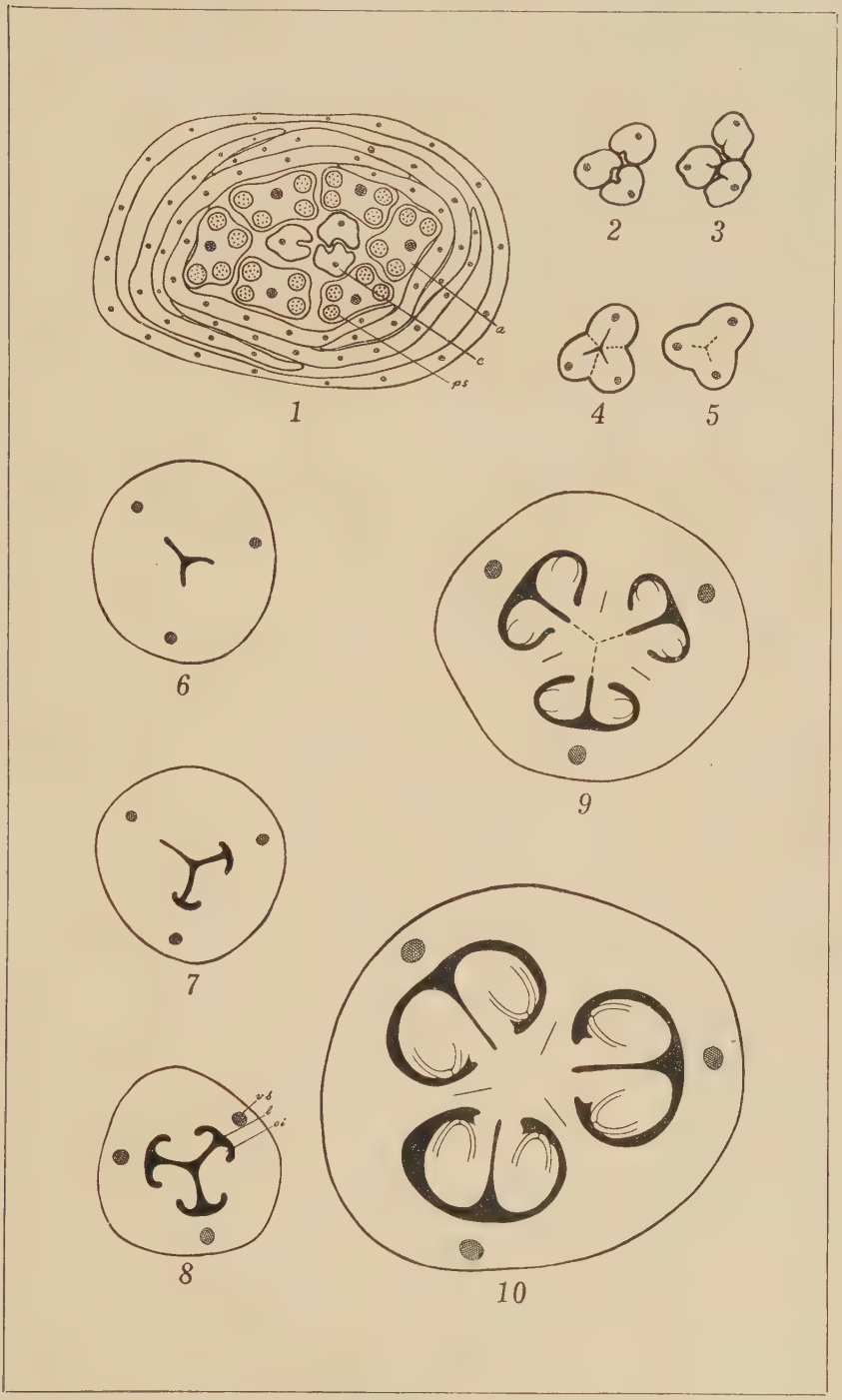


PLATE 3.



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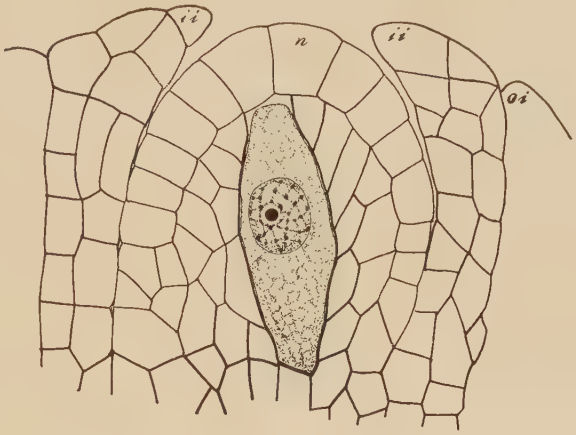

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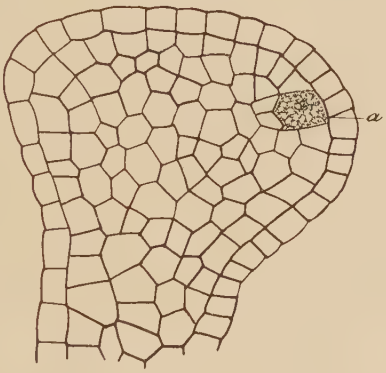

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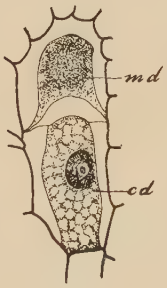

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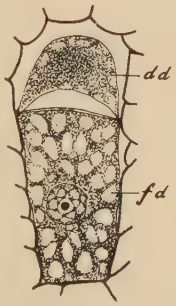

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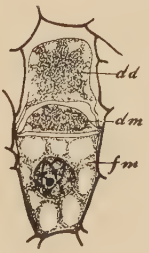

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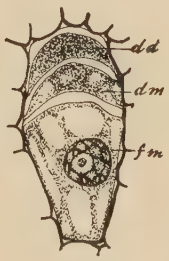

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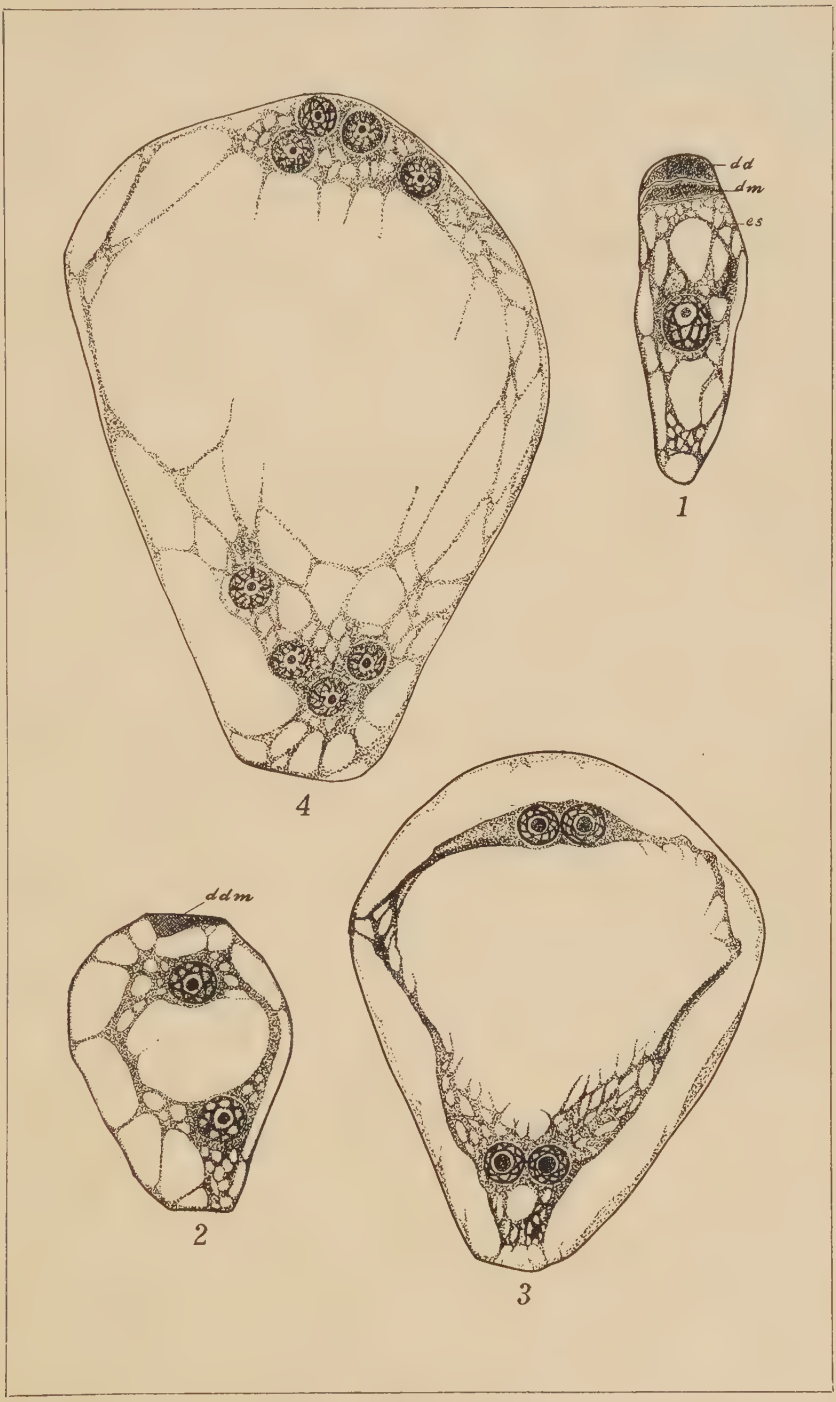
PLATE 5.



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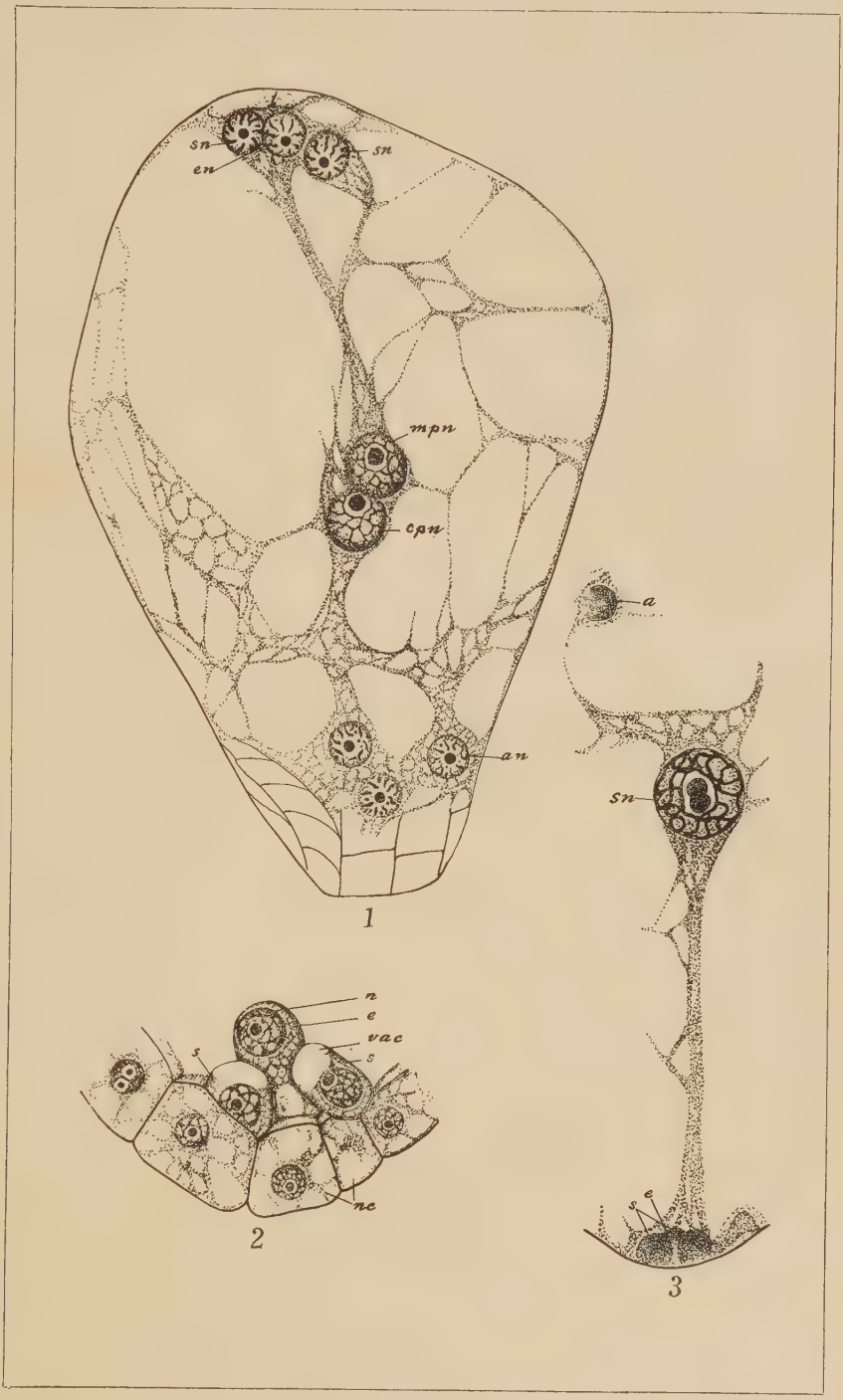
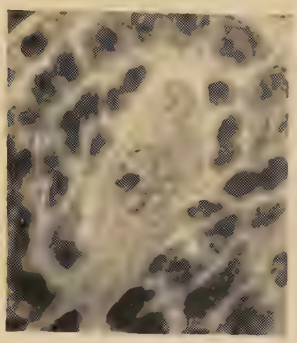


PLATE 7.



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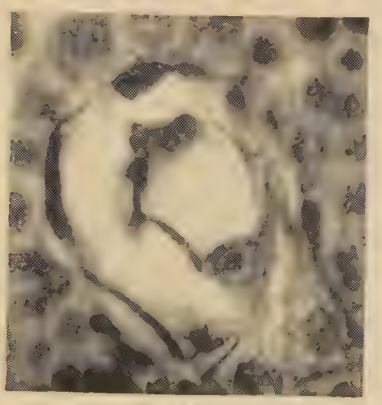

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PLATE 8.

BLEACHING PROPERTIES OF SOME PHILIPPINE CLAYS

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Institute of Science and Technology, Manila

Fuller's earth is extensively used in the mineral and vegetable oil industry as a clarifying and bleaching agent. Philippine prewar imports from 1934 to 1938 amounted to about a million and a half kilos of Fuller's earth valued at 23,000 pesos annually, while postwar imports, 1949 to 1951, had an annual average of 189,982 kilos valued at 40,623 pesos. The greater portion, if not all, is used for clarifying and bleaching vegetable oils for edible purposes.

Clays either are used in their natural state or are sometimes specially treated in order to increase their bleaching efficiency. Bleaching efficiency or the power to remove coloring matter from the oil, and the tendency to cause the minimum loss of oil due to absorption are the two essential properties that should be considered in using them in the oil industry.

In a preliminary investigation of the bleaching properties of some local samples, the senior author [1] has shown that a number of Philippine clays can be used for clarifying and bleaching purposes in place of imported Fuller's earth for use in the local vegetable oil industry.

Recently the authors had the opportunity to have several samples of clays, presented to them by one Mr. Charley Butler who collected the same from different parts of the Philippines and to test these samples for clarifying and bleaching purposes.

EXPERIMENTAL PROCEDURE

Each sample as received was first dried in the oven and powdered to pass through a 100–mesh sieve. It was then reheated in the oven at 105°C until free from moisture. This powdered dried clay was labeled as natural sample.

The treated sample was obtained by boiling the powdered clay (natural) with 5 per cent dilute hydrochloric acid for about thirty minutes. For every gram of powdered clay 10 cubic centimeters of diluted acid was used. The mixture was then allowed to settle and the product washed by decantation until

[1] Cruz, A. O. Some Philippine clays as possible bleaching agents for local vegetable oils. Philip. Jour. Sci. (3) 76 (1944) 23–27.

free from acid. The washed clay was then dried, ground, and passed through a 100–mesh sieve.

TABLE 1.—*Color readings of coconut oil bleached with different percentages of Philippine clays and imported Fuller's earth.*

Clay	Percentages of bleaching agent used			
	2		6	
	Red	Yellow	Red	Yellow
PHILIPPINES:				
A. Zambales, Olongapo, U. S. Naval Reservation:				
1. Km 116½, deposit.				
a. Natural	4.4	27.0	1.7	9.0
b. Treated	4.6	27.0	1.8	9.0
2. Km 116½, float.				
a. Natural	5.8	33.0	3.8	21.0
b. Treated	5.9	33.0	4.0	24.0
3. Km 122, deposit.				
a. Natural	3.4	21.0	1.2	9.0
b. Treated	3.9	21.0	1.9	9.0
4. Km 123½, deposit.				
a. Natural	5.0	30.0	2.4	15.0
b. Treated	5.2	33.0	2.8	15.0
5. Km 123–124 (clear)				
a. Natural	5.3	33.0	2.5	15.0
b. Treated	5.6	33.0	2.9	15.0
6. Km 123–124 (Colored)				
a. Natural	4.7	27.0	1.9	9.0
b. Treated	5.2	33.0	2.9	15.0
7. American Housing Project.				
a. Natural	4.0	24.0	1.5	9.0
b. Treated	2.2	15.0	1.3	9.0
8. Zambales, Salungahin, 1½ Km, South Subic Poblacion.				
a. Natural	4.8	27.0	2.4	15.0
b. Treated	4.4	27.0	2.0	12.0
9. Zambales, Subic Felipe.				
a. Natural	7.9	45.0	6.3	39.0
b. Treated	7.5	45.0	6.1	39.0
B. Rizal:				
10. Antipolo, 2 Km.				
a. Natural	3.3	21.0	1.1	6.0
b. Treated	2.7	15.0	0.8	5.0
C. Cebu:				
11. Toledo.				
a. Natural	5.5	33.0	2.7	15.0
b. Treated	5.2	33.0	2.4	15.0
D. Nueva Ecija:				
12. Pantabangan, Sitio of Ducong, Conversion.				
a. Natural	2.7	15.0	0.9	4.0
b. Treated	3.0	18.0	1.3	9.0
13. Pantabangan, Sitio of Ducong, Conversion. LAYER I				
a. Natural	3.2	21.0	1.4	9.0
b. Treated	2.5	15.0	1.1	5.0
14. Pantabangan, Sitio of Ducong, Conversion. LAYER II				
a. Natural	3.1	21.0	1.4	9.0
b. Treated	4.2	27.0	2.0	12.0
15. Pantabangan, Sitio of Ducong, Conversion. LAYER III				
a. Natural	2.5	15.0	1.2	7.0
b. Treated	4.2	27.0	2.5	15.0
16. Pantabangan, Sitio of Ducong, Conversion. LAYER IV				
a. Natural	3.2	21.0	1.4	9.0
b. Treated	2.7	15.0	0.9	5.0
E. Imported:				
a. Fuller's earth 1	4.2	27.0	1.6	9.0
b. Fuller's earth 2	3.2	21.0	1.1	6.0

The bleaching efficiency of each clay was determined according to the bleach test described by Jamieson,[2] modified by using, however, different percentages of earth. The color of the treated oil was determined according to the method adopted by the Coconut Oil Manufacturers of the Philippines. The oil used in all the tests was a commercial grade coconut oil with a color reading of 6.5 Red and 39.0 Yellow. The names of the places from which the samples of clays were collected and the results of the bleaching tests are recorded in Table 1.

Table 1 gives the color readings of a commercial grade coconut oil bleached with different percentages of Philippine clays and two samples of imported Fuller's earth. As shown by the data all the clays tested have bleaching properties when used in their natural state with the exception of sample 9 which discolored the oil. Clay 1 has a slightly lower bleaching efficiency than the imported earths. Clay 10 gives the same bleaching efficiency as Fuller's earth 2, but higher than earth 1. Sample 12 has a higher decolorizing efficiency than either Fuller's earths 1 or 2. Clays 3, 7, 13, 14, 15, and 16 have higher bleaching efficiencies than the imported earth 1, but lower than imported earth 2.

When specially treated, samples 7, 8, 10, 11, 13, and 16 have better bleaching properties than when they are used in their natural state, while the other treated samples give the same or slightly lower decolorizing efficiencies.

In determining the loss of oil due to absorption, the procedure for the bleach test was followed, but modified in that filtration was done by a buchner funnel as suggested by Richert.[3] When the clay seemed to be dry, vacuum was continued for fifteen minutes. The residue was removed from the funnel and weighed. The amount of clay used in this test was 6 per cent.

Table 2 gives the results of the absorption of oil by Philippine clays and two samples of Fuller's earth. This table shows that clay 5 absorbs less oil than Fuller's earth 2 but more than imported earth 1. Clay 2 gives the same percentage loss of oil as imported earth 2 but higher than that of earth 1. The other clays tested in their natural state give higher percentages

[2] Jamieson, G. S. Vegetable Fats and Oils, Their Chemistry, Production and Utilization for Edible, Medical Purposes. (2nd ed.; New York: Reinhold Publication Corp., 1943) 398.

[3] Richert, T. G. Fuller's earth and its valuation for the oil industry. Ind. Eng. Chem. Jour. 9 (1917) 599.

TABEL 2.—*Absorption of oil by some Philippine clays and two samples of imported Fuller's earth.*

Bleaching agent used.	Bleaching agent plus oil	Oil absorbed
	Grams	*Per cent*
PHILIPPINE CLAYS:		
A. Zambales, Olongapo, U. S. Naval Reservation.		
1. Km 116½, deposit.		
a. Natural	24.3	35.0
b. Treated	23.1	28.3
2. Km 116½, float.		
a. Natural	22.9	27.2
b. Treated	21.0	16.6
3. Km 122, deposit.		
a. Natural	26.0	44.4
b. Treated	23.4	30.0
4. Km 123½, deposit.		
a. Natural	24.2	34.4
b. Treated	27.9	55.0
5. Km 123-124 (Clear)		
a. Natural	22.6	25.5
b. Treated	27.3	51.6
6. Km 123-124 (colored).		
a. Natural	25.2	40.0
b. Treated	22.2	23.3
7. American Housing Project.		
a. Natural	26.4	46.6
b. Treated	25.5	41.6
8. Zambales, Salungahin, 1½ Km. South Subic poblacion		
a. Natural	25.7	42.7
b. Treated	22.5	25.0
9. Zambales, Subic Felipe.		
a. Natural	20.7	15.0
b. Treated	21.0	16.0
B Rizal:		
10. Antipolo, 2 Km.		
a. Natural	30.3	68.3
b. Treated	29.1	61.6
C. Cebu:		
11. Toledo.		
a. Natural	24.7	37.2
b. Treated	23.7	31.6
D. Nueva Ecija:		
12. Pantabangan, Sitio of Ducong, Conversion.		
a. Natural	27.6	53.3
b. Treated	27.6	53.3
13. Pantabangan, Sitio of Ducong, Conversion. LAYER I		
b. Natural	33.1	83.8
a. Treated	28.2	56.6
14. Pantabangan, Sitio of Ducong, Conversion. LAYER II		
a. Natural	34.2	90.0
b. Treated	27.5	52.7
15. Pantabangan, Sitio of Ducong, Conversion. LAYER III		
a. Natural	25.4	41.1
b. Treated	24.0	33.3
16. Pantabangan, Sitio of Ducong, Conversion. LAYER IV		
a. Natural	28.5	58.3
b. Treated	24.6	36.6
E. Imported:		
a. Fuller's earth 1	22.3	23.8
b. Fuller's earth 2	32.9	27.2

loss of oil than the imported earths, ranging from 33.8 to 68.3 per cent. Treated clays 4, 5, and 9 absorb more oil than when used in their natural state, while the remaining ones give less percentages loss of oil than the untreated samples.

SUMMARY AND CONCLUSION

Sixteen samples of Philippine clays were tested. Fifteen of these clays when used in their natural state have been found to have bleaching properties. When especially treated, five samples gave better decolorizing and clarifying efficiencies, while the other treated clays have the same or slightly lower bleaching properties than when used in their natural state.

Ten of these clays have the same or slightly lower bleaching efficiencies than the imported Fuller's earths.

The percentages of loss of oil due to absorption are higher in most of the local clays than in the imported earths.

The results show that some local clays are as good as the imported Fuller's earths for clarifying and bleaching purposes.

THE PURIFICATION OF NATIVE COMMERCIAL SALT

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Native commercial salt is generally impure because of the inadequate techniques employed in its production. As cited by Ablan, et al. (1) and Cox and Dar Juan (2), these techniques vary, but they all involve the evaporation of salt either by means of the heat of the sun or by means of heating with firewood as fuel. The product obtained by either of these methods only contains about 83 per cent sodium chloride; it is not good for table use and is not suitable for making good *bagoong* and much less suitable for the electrolytic production of caustic soda and chlorine.

In describing local methods of making salt, Cox and Dar Juan recommended ways of improving these, but did not perform any experiment to show the merits of their recommendations. Ablan, et al. who also described the methods observed by them neither made any suggestion or recommendation, nor they have conducted any experiment for better methods or procedures.

Hamm (3) recommended the crystalization of salt in deep ponds and washing the resulting crystals with fresh water. He claimed that with this method a product with 99.5 per cent sodium chloride could be obtained, but an analysis of the salt produced with his experimental process showed only 97.5 per cent sodium chloride. The salt so obtained is good for table use and for preserving and processing fish products. It is also good raw material from which sodium chloride suitable for the electrolytic production of caustic soda and chlorine may be obtained and purified.

Object.—The purpose of this paper is to report a method of purifying native commercial salt to improve its grade for domestic and technical uses as salts produced in other countries.

PRELIMINARY OBSERVATIONS

A sack of native commercial salt produced by solar evaporation was bought from Las Piñas, Rizal. In its commercial state, the salt was analyzed, the results being indicated in Table 1.

TABLE 1.—*Analysis of native commercial salt.*

	Per cent	Per cent Moisture free
Moisture at 250°C (4)	12.28	.....
Water insoluble residue	0.21	0.24
R_2O_3	0.71	0.80
CaO	0.61	0.70
MgO	0.94	1.07
SO_3	1.73	1.98
Nacl by difference	83.53	95.21

The sack was suspended within a well ventilated building. The water content was allowed to drip for a period of one month. At the end of the period, the salt in the sack was again analyzed. Table 2 shows the composition of the salt.

TABLE 2.—*Analysis of the salt after dripping for 30 days.*

	Per cent	Per cent Moisture free
Moisture	3.00	.....
Water insoluble residue	0.57	0.59
R_2O_3	0.46	0.48
CaO	0.46	0.48
MgO	0.04	0.05
SO_3	1.02	1.04
Nacl	94.45	97.36

A comparison of the results shown in Table 1 and Table 2 reveals a considerable decrease in the per cent of moisture, R_2O_3, CaO, MgO, and SO_3, but an increase in water insoluble residue, owing to the contamination of the sample with the deteriorated sack. The purity of the salt also increased.

METHOD OF PURIFICATION

With the use of tap water, a 35 per cent solution of the salt mentioned in Table 2 was prepared and filtered. Of the preparation of a little over four liters (4,150 cc), about 2.5 was evaporated in a four-liter porcelain dish, placed on top of a circular can about a foot high and set on a hot plate with the heat so regulated as to approximate that of the sun. To prevent the salt crystals from creeping outside the dish, coconut oil was applied on the rim two inches below it, and a few drops of the same oil were also dropped on the surface of the solution, as suggested by Rogers (5). As the evaporation progressed, the rest of the filtrate was added in small portions until the solution began to crystalize. During the process, in no case was the supernatant liquid allowed to

remain less than two inches above the crystals. When this liquid reached about two inches above the crystals, it was drained of, and the recovered crystals were marked "good quality salt" and put aside for further treatment.

The residual solution was again evaporated until the supernatant liquid was one inch above the salt crystals. The liquid was poured off carefully bringing with it the coconut oil and other impurities in the solution. The residue obtained measured 400 cc. Both the second crop of salt and the first crop, which were kept separate, were analyzed, the results being shown in Table 3 and Table 4.

From the 4,150 cc of 35 per cent brine, 850 grams of "good quality salt" of 99.74 per cent purity (Table 3), 444 grams of second crop salt of 97.68 per cent purity (Table 4), and 400 cc of impure brine containing 140 grams of salt were obtained. The percentage of purity of the first and second crops of salts was on moisture free basis. The total salt recovered was 1,294 grams, indicating a loss of 158.5 grams based on the 1,452.5 grams at the start, including the 140 grams obtained from the supernatant liquid. There was, therefore, an unaccounted loss of 18.5 grams of salt. The total loss was 10.92 per cent, composed of 9.65 per cent of salt in the brine and 1.27 per cent undetermined.

TABLE 3.—*Analysis of the good quality salt crystals.*

	Per cent Moisture free
CaO	0.07
MgO	0.03
SO_3	0.16
Nacl (by difference)	99.74

The analysis of the good quality salt (Table 3) showed that the lime content of the sample mentioned in Table 2 was reduced from 0.48 to 0.07 per cent, the magnesium from 0.05 to 0.03 per cent, and the sulphur trioxide, from 1.04 to 0.16 per cent. The purity of the sample, increased from 97.36 to 99.74 per cent.

TABLE 4.—*Analysis of the second crop salt crystals.*

	Per cent	Per cent Moisture free
Moisture	1.41	.....
CaO	0.71	0.72
MgO	0.36	0.37
SO_3	1.22	1.23
Nacl	96.30	97.68

Table 4 shows that in composition the second crop salt fare better than the commercial table salt made locally. Compared with imported commercial salt (Table 5), however, with the exception of MgO, it has somewhat higher percentage of impurities.

TABLE 5.—*Analysis of Taiwan commercial salt.*

	Per cent Moisture free
Water insoluble residue	0.54
CaO	0.08
MgO	0.39
SO_3	0.26
Nacl	98.73

To purify further the "good quality salt" crystals, it was submerged with a saturated hot solution of the salt mentioned in Table 3, and agitated for two or three minutes. The brine was then poured out to another container for use for another washing or for recrystalization after combination with a 35 per cent solution. The washed crystals were dried again at 250°C for 2 hours and analyzed, the results being indicated in Table 6.

TABLE 6.—*Analysis of washed high grade salt crystals.*

	Per cent			Per cent
CaO	0.038		$CaSO_4$	0.021
MgO	0.010	or	$CaCl_2$	0.034
SO_3	0.030		$MgCl_3$	0.020
Nacl	99.920		.....	99.920

The purity of the salt as treated above was found to be, by analysis using uranyl zinc acetate of Kalthoff (6), 100.02 per cent. This almost checks the per cent of the sodium chloride by difference. In obtaining this purity, it is evident that salt made locally can be purified to a high degree comparable to that of the imported varieties. The final product showed the presence of 0.034 per cent $CaCl_2$ and 0.020 per cent $MgCl_2$. These components, which are highly hydroscopic, tend to cause the product to "cake" (7), a tendency which may be corrected by adding a small amount of either starch to coat each grain of salt, or sodium bicarbonate to convert the magnesium and calcium chlorides into carbonates which are not hydroscopic, if the product is to be used as table salt.

SUMMARY

1. The reports of local authors on commercial salt, sodium chloride, were studied.

2. A method of purification of native commercial salt, which produces two grades of salt, is described.

3. The first grade of salt produced by the said method has a purity of 99.92 per cent, which is comparable to that of the imported ones.

4. The remaining impurities of the purified salt are CaO, 0.038 per cent, MgO, 0.010 per cent, and SO_3, 0.030 per cent. When calculated into their corresponding compounds, these impurities are $CaSO_4$, 0.02 per cent, $CaCl_2$, 0.034 per cent, and $MgCl_2$, 0.020 per cent.

5. The second grade of salt obtained has a purity of 97.68 per cent, on moisture free basis, which renders it marketable as commercial salt.

6. Based on the treated commercial salt, there is a total loss of 10.02 per cent composed of 9.65 per cent salt in the supernatant liquid and 1.27 per cent undetermined losses. The recovery is 89.08 per cent.

ACKNOWLEDGMENT

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THE POSSIBILITIES OF SALINAS SPRING AS A SOURCE OF SALT

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In 1915, in their report on a survey of Salinas Spring, Cox and Dar Juan(2) mentioned about the natives producing 120,000 kilograms of salt yearly from the spring. In 1924, Smith(4), who also visited the same spring, observed that the water was "only very slightly thermal" and was used by the natives for making salt. In his book referred to (see Plate 20, fig. 2) he reproduces a good picture of the spring. The spring, as observed by the writer in his recent trips to the locality made on July 18 and on December 26, 1952, appeared generally the same as shown in that picture.

During the Japanese occupation, the entire Cagayan Valley, wherein the spring is located, was cut off from Pangasinan Province, its source of supply of salt. The resulting shortage of salt forced most of the people in the region to take their meals without salt. This commodity became so scarce and expensive that people, who could not get along without it, had to exchange a cow or a carabao for a ganta or three liters of it. This was a bitter lesson to the people.

Recently, the Office of Economic Coordination was requested by the provincial government of Nueva Viscaya to resurvey Salinas Spring to determine whether the spring has the potentiality to yield enough salt to meet the needs of the whole Cagayan Valley in order that it may not have to depend again on other regions for its supply of salt in times of stress. On July 18, 1952, at the instance of the said Office, a trip was made by the writer to the spring, which is located 13 kilometers west of Bambang, Nueva Viscaya. In this trip, samples were collected of solid deposits on the bed of the spring, of deposits on twigs in contact with the water, of salt made by the natives, of fresh water from the spring, and of the water stored three or more days and used by the natives for making salt. These samples were analyzed in accordance with the methods reported by Scott(3) and the American Public Health Association(1) with some modifications. Tables 1, 2, and 3 show the results of the analyses.

46753——3

TABLE 1.—*Analysis of solid deposits from the bed of the spring and from twigs.*

	Per cent
Silica (SiO_2)	0.10
Oxides of Fe and Al (R_2O_3)	0.36
Calcium as Calcium Carbonate ($CaCO_3$)	98.20
Magnesia (MgO)	0.30

TABLE 2.—*Analysis of the salt made by the natives.*

	Per cent
Moisture	3.40
Residue insoluble in water	0.43
Silica (SiO_2)	0.28
Oxides of Fe and Al (R_2O_3)	0.27
Sulfur trioxide (SO_3)	3.25
Lime (CaO)	1.26
Magnesia (MgO)	0.52
Nacl (By difference)	90.59

TABLE 3.—*Analysis of the fresh and old water.*

Parts per million	Fresh water	Old water
Normal carbonate	nil	70
Acidity as CO_2	240	nil
Alkalinity as $CaCO_3$	3,310	375
Bicarbonate HCO_3	3,970	170
Total solids	39,290	49,000
Appearance on ignition	no change	no change
Silica	100	21
Calcium	1,500	154
Magnesium	305	651
Sulphate	1,280	3,110
R_2O_3	20	40
Iron	9.2	2
Aluminum	10.4	19
Chlorides	19,500	27,400
Estimated alkalies	13,490	19,329

Table 1 shows that the deposits on the beds of the spring and on twigs are made up mostly of limestone containing 98.2 per cent calcium carbonate. Table 2 shows that the purity of the salt made by the natives is by analysis around 90.60 per cent. In the case of the fresh water and the water three or more days old, the analysis shown in Table 3 reveals the changes that the water undergo from the time it springs out to the time it is evaporated for its salt content. As soon as the fresh water, which is highly loaded with carbonic acid gas and bicarbonates, is exposed to the air, the carbon dioxide begins to escape. As the water flows, the calcium carbonate precipitates forming the

bed deposits. This explains the massive limestone bed of the spring and the solid deposits on twigs along the course of the water. The bicarbonate of lime continues to decompose into $CaCO_3$, H_2O, and CO_2 as shown by the reaction: $Ca(HCO_3)_2$—$CaCO_3 + H_2O + CO_2$. The small amount of calcium carbonate present in the salt made by the natives indicates that the bicarbonate is not completely decomposed when the old water is boiled into salt.

The fresh water contains 240 p.p.m. CO_2, normal carbonate, nil, while the three or more days old water contains 70 p.p.m. normal carbonate, CO_2, nil. The silica is not decomposed. Most of it is deposited on the way as the water leaves the spring. Of the 100 p.p.m. silica content of the fresh water, only 21 p.p.m. are left in the old water. The greater part of the 1,500 p.p.m. calcium bicarbonate content of the fresh water is deposited on the way as calcium carbonate, leaving only 154 p.p.m. after about three days' exposure to the atmosphere.

Table 3 shows, on the other hand, that the Mg, SO_4, R_2O_3, Fe, Al, Cl, and estimated alkalies in the fresh water increased considerably in the old water. The increases may be explained by the fact that both samples were analyzed on the basis of one liter volume each with the results calculated in p.p.m.

The magnesium exists probably as sulfate or chloride and not as bicarbonate, and the alkalies are present mostly as chlorides and very slightly as sulfates. The composition of silica remains unaffected. On the way, most of the calcium is deposited as calcium carbonate. The free CO_2 and CO_2 evolved due to the decomposition of the bicarbonates escape to the air bringing with it water vapor and reducing the original volume. The one liter of the fresh water then is somewhat reduced in volume and the concentration of the salt is increased considerably. At this concentration, however, the Mg, SO_4, Cl, and estimated alkalies remain in solution. Fe and A_1, present as bicarbonates, decompose into hydroxides and CO_2, as shown by the reaction $Fe(HCO_3)_3$—$Fe(OH)_3 + 3CO_2$ after two or three days. This explains the total increase in solids, naturally due to the decrease in volume, found in the old water.

In the trip made to the spring on December 26, 1952, twenty liters of the three or more days old water were taken, the specific gravities of the fresh and old water were determined and the rates of flow per day of its two outlets were measured.

Both water samples showed a specific gravity of 1.03 at 28°C. Of its two outlets the lower one gave a rate of flow of 21,096

liters per day, the upper, 10,555 liters per day. Combining the two, which are about 50 feet apart, the spring has a daily output of 31,651 liters or 32,600 kilos of salt water. Considering that the salt content of the water, as determined by laboratory analysis is 4 per cent, it is estimated that both springs would give a theoretical yield of 1,300 kilos, or 1.3 tons of salt daily. Such a yield would be enough to supply the whole Cagayan Valley and other provinces of Luzon with this commodity.

PREPARATION OF SALT

Local method.—The local method employed in preparing salt from the spring may be described as follows: The water from the spring is channelled through bamboo tubes split into halves to a level land below where it is stored for three or more days before it is evaporated for its salt content. Empty army gasoline drums opened lengthwise by cutting off about one-third the sides of same serve as evaporators. These drums are placed close together and, with the salt water poured in, are heated moderately using firewood from the nearby forest as fuel. Evaporation is continued until the salt crystals become dry on cooling. The salt harvest is then put in either bamboo baskets or buri sacks ready for the market.

Modified method.—The procedure, a modification of the local method, followed to improve the yield of salt may be described as follows: Seventeen and a half liters of the 20 liters of sample of three or more days old water were evaporated to about one-eight of the original volume, or until the specific gravity was 1.195 at 90 to 95°C. The solution was filtered and the filtrate was evaporated until the remaining liquid was just above the crystals of salt. The liquid was then carefully poured out leaving the crystals of salt to dry. Since 625 grams of dry salt were produced out of the 17.5 liters of salt water, the modified method used showed a recovery of 3.47 per cent of salt. Since the salt content of the water is 4 per cent, the loss was 0.53 per cent of salt. Taking this loss into account, the actual amount of salt that can be produced daily from the spring is 1.13 tons, instead of the theoretical amount of 1.3 tons.

The analysis of the salt produced by the above method is as follows:

	Per cent
Water insoluble residue	0.09
R_2O_3	0.08
Lime (CaO)	0.31
Magnesia (MgO)	0.22

	Per cent
Sulfur trioxide (SO_3)	1.95
Sodium chloride (by difference)	97.35
Total	100.00

The above indicates that the salt produced by the modified method described above is 97.35 per cent pure, while the salt made by the local method is 90.59 per cent pure. Besides the salt produced by the former method is white, less hygroscopic, less bitter, and tastes saltier than that produced by the latter.

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DISCOVERY OF LIVING SPECIMENS AND RE-DESCRIPTION OF PANDAKA PYGMÆA HERRE

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ONE TEXT FIGURE

This is a report on a discovery of living specimens of *Pandaka pygmæa* Herre,* the world's smallest fish. This fish was described in 1927 by Herre, who stated, "The specimens were in a bottle with fish collected in 1907 from Malabon, Rizal, but whether they also came from there is uncertain." The species has never been encountered in Malabon or elsewhere in the Philippines since its discovery twenty-four years ago. This fact and the uncertainty of the exact date of collection and data on locality have caused many ichthyologists to doubt the validity of the species. This report on the re-discovery of this fish in Malabon River, Rizal, right in the vicinity of the Dagatdagatan Salt-Water Fishery Experimental Station is therefore significant.

Living specimens were first found among planktonic materials being studied in 1950 by Mr. H. R. Rabanal of the Philippine Bureau of Fisheries, who suspected them to be conspecific with Herre's *P. pygmæa.* A year later, on February 28, 1951, Mr. R. Esguerra also of the Bureau of Fisheries, while collecting plankton for his studies, found again in Dagatdagatan some very small but definitely mature (some gravid) fish which he gave the senior author for examination. They were found to be *P. pygmæa* of Herre, and some specimens were stained for further study. In the summer of 1952 Esguerra again reported the presence of the species in the same locality.

In January, 1953, the junior author was assigned at the Dagatdagatan Salt-Water Fishery Experimental Station, Malabon, Rizal. This afforded him more opportunities to observe the habits of this peculiar species. Subsequent studies revealed that the fish occurs throughout the year and apparently abound during the months from January to June, appearing along the banks when the water is clear and the tide is rising. The fish frequents the banks of Dagatdagatan, especially that portion below the Administration Building which offers a shaded area during noon time. During the rainy season when the water of Dagatdagatan is turbid the fish enters the main gate of the fishpond and is

* *Plesiotype* and *topotypes* are deposited in the National Museum, Manila, Philippines.

observed inside the supply canals. Studies also revealed that live specimens kept in a glass aquarium for the five months from July to November of 1953 and fed with rice bran looked healthy and behaved normally.

After carefully studying the specimens and comparing them with paratypes from Stanford Natural History Museum, the writers established the fish to be *Pandaka pygmæa*. Comparing its specimens with the figure of the fish in Herre's work (1927), they noted inaccuracies in the drawing, particulary in the relative lengths of the first three rays of the first dorsal, the shape of the mouth, shape of caudal, etc.

This paper presents a detailed description of *P. pygmæa* (Fig. 1A) based on 52 specimens collected at Dagatdagatan, Malabon, Rizal, with notes on the condition of the water when they were collected.

PANDAKA PYGMÆA Herre.

Pandaka pygmæa HERRE, Gobies of the Philippines and the China Sea. Bureau of Science, Manila, Monograph 23 (1927) 198–199, *pl. 14, fig. 4.*

(Original description based on 75 specimens taken from a bottle with big fishes presumably collected from Malabon, Rizal in 1907).

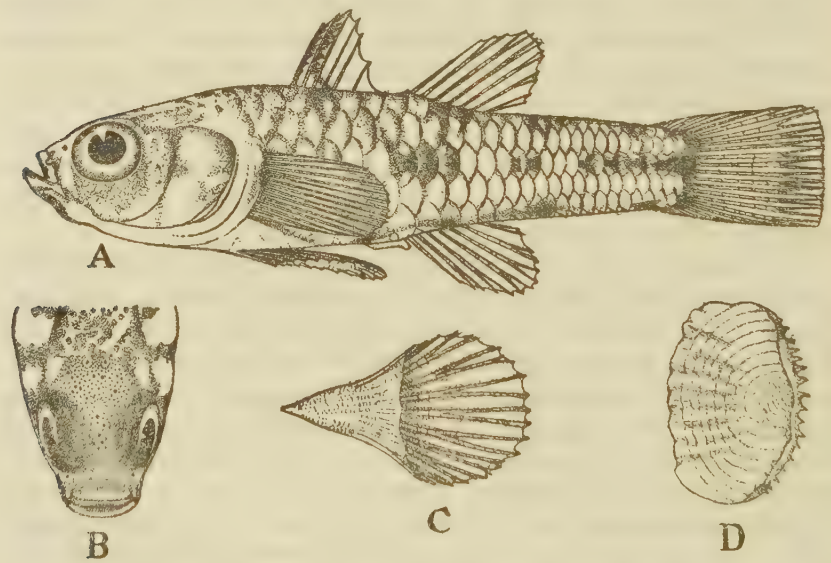

FIG. 1. *Pandaka pygmæa* Herre. A. Lateral view. B. Dorsal surface of head. C. Ventral surface of ventral fins (united). D. Scale taken from side of body below first dorsal greatly magnified. (All figures drawn from a specimen 9.48 mm in standard length by B. V. Escuadro, Bureau of Fisheries, Manila.)

Measurements and counts.—To make the necessary measurements and counts more precise all the specimens (52 individuals) used in this investigation were treated with alizarine stain (Hollister, 1934), and measured with the aid of a stereoscopic microscope and micrometer ocular.

Measurements in per mille of standard length based on 52 specimens 7.60 to 11.44 mm (average 9.66 mm) in standard length: length of head 301 (276 to 318); diameter of orbit 94 (100 to 129); length of maxillary 94 (83 to 106); length of snout 44 (35 to 54); interorbital space 38 (31 to 53); depth (measured from origin of dorsal) 244 (200 to 294); least depth of caudal peduncle 116 (102 to 126); distance from D_1 (first dorsal) to pectoral 105 (88 to 142); distance from D_1 to ventral 244 (201 to 285); distance from D_1 to anal 293 (246 to 331); distance from D_1 to D_2 (second dorsal) 188 (170 to 217); distance from snout to D_1 423 (396 to 444); distance from snout to ventral 364 (338 to 388); distance from snout to pectoral 346 (308 to 373); pectoral base 96 (83 to 111); first dorsal base 95 (83 to 108); second dorsal base 115 (96 to 143); anal base 95 (88 to 125); distance from base of fifth ray to sixth ray of D_1 38 (28 to 51).

The following measurements are based only on the number of specimens whose fin rays are in perfect condition (measured from origin to most posterior tip) in per mille of standard length: Length of first dorsal 169 (145 to 205), fifteen specimens counted; length of second dorsal 225 (208 to 234), eight specimens counted; length of anal 214 (200 to 230), six specimens counted.

Fin formula.—D. VI–I, 6 (I, 6 to I, 7); A. I, 6 (I, 6 to I, 7); P. 15 (15 to 17); V. I, 5; C. 13.

General form.—Body moderately elongate, robust, dorsal and ventral contours roughly parallel anterior to origin of second dorsal, somewhat narrowing under the same (D_2) posteriorly and then tapering gently to a rather heavy caudal penduncle. Upper anterior profile flattened or very gently curved above eyes; snout bluntly pointed; mouth moderate, slightly superior.

External body details.—Head and nape naked; body robust, anterior half subcylindrical, posterior half moderately compressed becoming prominent at caudal region; entire body covered by firm and strongly ctenoid scales, (Fig. 1D), proportionately large and gradually diminishing in size anteroposteriorly, 24 (22 to 25) in longitudinal series. No lateral line.

Head.—Eye large, orbital diameter (measured horizontally) 2.55 (2.20 to 2.98) times in head. Two pairs of nostrils comparatively moderate in size, anterior pair somewhat tubular, their openings touching the antero-dorso-lateral margin of snout. Orbit covered with a transparent leathery skin continuous with that of head, the fronto-dorsal border heavily pigmented (Fig. 1B) covering the white portion of anterior chamber of eye; pupil oval. Head as broad as depth in the hind region of opercle, about one-third of standard length; a narrow and hardly visible groove runs posteriorly along dorso-median axis extending to the bases of first and second dorsals; snout relatively moderate, bluntly pointed, 7 (5.5 to 8.3) times in head and almost one-half diameter of orbit. Mouth markedly oblique, lower jaw projecting, making it clearly superior. Maxillary moderate, on a vertical extending posteriorly between tip of snout and anterior border of orbit. There are two rows of teeth on each jaw, the outer ones distinctly larger and more widely-set than those of the inner rows which are "fine and similar to teeth of a microscopic saw." Gill opening moderate, restricted to sides, rather gently rounded, its dorsal and most posterior border bluntly pointed; gill membrane attached to a broad isthmus; gill rakers moderately large and wide-set, brachiostegals five.

Fins.—First dorsal clearly in advance middle of body, origin midway between tip of snout and a point somewhere middle of caudal base and base of last ray of second dorsal; length of first ray one-half depth of body, the next two rays progressively becoming longer, the third being the longest, its length approximating depth of caudal peduncle, the rest of the rays progressively becoming shorter, the last ray shortest, its length equal to diameter of iris or one-half diameter of orbit. Origin of second dorsal midway between caudal base and a vertical to hind border of preopercle. Pectoral base (lower end base) sligthly in advance origin of first dorsal, about twice nearer ventral than to dorsal body margin, its tip clearly behind base of last ray of first dorsal, the length approximating twice diameter of orbit. Ventrals markedly thoracic in position, base directly below lower end of pectoral base, each having one spine and five soft rays, the two fins completely joined to form a single fin (Fig. 1C) adapting it for sucking or clinging to surfaces, its length approximating that of pectoral fins. Anal origin directly below origin of second dorsal, approximating size and shape of the latter. Caudal truncate, its length equal to distance between origins of first dorsal and ventrals.

Coloration.—Color in formalin dull-yellow to grayish, the degree of pigmentation varying from light blackish-brown to very black spots somewhat forming four cross-bands along sides of body. Heavy pigmentations also characterize all bases of various fins which are apparently the continuation of body pigmentation except ventrals. Bands on anterior region usually wider, the degree of pigmentation lighter than those on posterior region which are usually heavier. In live specimens the coloration is very conspicuous although the degree of pigmentation in different individuals also vary.

Conditions of the water when collection was made.—The specimens were collected on February 28, 1951, with the following conditions at the Dagatdagatan Lagoon:

Time	10:45 to 11:45.
pH	6.8 p.p.m.
Salinity	34.06 p.p.m.
Temperature	Air—30°C; Water—26°C.
Weather	Fair, Wind SW.
Turbidity	73.5 cm. (Secchi disc).
Dissolved oxygen	1.6629 to 2.2865 p.p.m. (The specimens were captured on the side with a minimum dissolved oxygen).

ACKNOWLEDGMENT

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RECORDS AND DESCRIPTIONS OF JAPANESE TIPULIDÆ (DIPTERA), PART IV

THE CRANE-FLIES OF SHIKOKU, IV

By Charles P. Alexander
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FOUR PLATES

The present report, continuing the survey of the crane-flies of Shikoku, adds 53 species to the three preceding lists, bringing the total as now known from the island to the impressive figure of 263. It is certain that the record still remains incomplete and that many additional species will be discovered as a result of future collecting. The species recorded at this time were taken chiefly in Iyo by Messrs. Michio Chûjô, Tadao Edashige, Hidenobu Ide, Tamotsu Ishihara, Hiroyuki Kusunoki, Mutsuo Miyatake, Terunori Mohri, Tetsusaburo Tachikawa, K. Tachechi, and Toshiro Yano. Some interesting records were made in the Omogo Valley on November 12, 1953, on the occasion of the mountain field trip of the members of the Entomological Society of Japan following the annual meeting held earlier in Matsuyama. Various persons in the above list, together with Dr. Teiso Esaki, of Fukuoka, and other visiting entomologists, participated in this excursion. A few further records are from Sanuki, taken by Chûjô, and from Tosa, by Edashige. I wish to express my continued appreciation to all of these friends and co-workers who have aided so materially in developing the list of Tipulidæ of Shikoku.

In the initial part of this series of Records [1] it was stated inadvertently that the division of the Japanese Empire into Kuni, or Provinces, was more recent than that into Ken, or Prefectures. This is incorrect; the more ancient division was into Provinces or Kuni, the use of Prefectures or Ken, although now generally in use in a political and public sense, dating only from 1871.

[1] Philip. Jour. Sci. 82 (1953) 21.

RECORDS OF DISTRIBUTION

TIPULINAE

Subtribe CTENOPHORARIA

Ctenophoraria ALEXANDER, Cornell Univ. Mem. 38 (1920) 986.
Pselliophorinina MASAKI, Mushi 6 (1933) 77.

CTENOPHORA Meigen

In an earlier paper [2] I have provided a key to the then recognized genera of the Ctenophoraria and indicated the increasing difficulty in maintaining these supposed genera except on trivial characters based primarily on the structure of the male antennæ. I now feel that the time has come when it is no longer logical or possible to continue to maintain the names as representing valid genera and am placing the following five names as subgenera under the oldest name *Ctenophora: Ctenophora, Dictenidia, Phoroctenia, Pselliophora,* and *Tanyptera.* Of these, *Phoroctenia* and *Pselliophora* might well be held to be untenable and be relegated to strict synonymy.

A course such as the above finds an almost exact parallel in the subgenus *Rhipidia* Meigen of the genus *Limonia* Meigen where several supposedly valid subgenera have been relegated into the synonymy of the subgenus. The male antennæ in *Rhipidia* are commonly bipectinate, unipectinate or subpectinate but there are some species where an unequal tripectinate condition is found. Moreover, in this subgenus there is to be found a considerable range in the length of the branches of the antennæ in the males of various species, in the extreme cases these being fully as long, proportionate to the size of the insect, as is found in *Pselliophora,* where the maximum length in the present genus is to be found. Further, the antennæ in the female sex in *Rhipidia* are almost invariably simple or weakly subpectinate, as in the present instance. At this time it is uncertain whether *Prionota* van der Wulp, with *Plocimas* Enderlein, is actually distinct from *Ctenophora* or merely represents an extreme reduction of the pectinate condition of the antennæ in this genus. The various subgenera listed above are as follows:

CTENOPHORA Meigen

Flabellifera MEIGEN, Nouv. Class. Mouch. (1800) 13; *nomen nudum.* (Diagnosis, with indication of four unnamed species).

[2] Philip. Jour. Sci. 60 (1936) 167–168.

Ctenophora MEIGEN, Illiger's Mag. 2 (1803) 263. (The above four species validated by names: *pectinicornis, bimaculata, atrata,* and *flaveolata*). Genotype: *pectinicornis* Linnæus, designated by Westwood, 1840; pseudotype, *flaveolata* Fabricius, by Rondani, 1856.

Cnemoncosis ENDERLEIN, Zool. Anzeig. 52 (1921) 219; type *nohiræ* Matsumura, as *hilgendorfi* Enderlein.

TANYPTERA Latreille

Tanyptera LATREILLE, Hist. Nat. Crust, et Ins. 14 (1805) 286. (Removed *atrata* Linnæus from the above Meigen list; subgenotype).

Xiphura BRULLÉ, Soc. Ent. France Ann. 1 (1832) 206; type *atrata.*

Mesodictenidia MATSUMURA, 6,000 Illus. Ins. Japan Empire (1931) 395; type *jozana* Matsumura, as *macræformis* Matsumura.

DICTENIDIA Brullé

Dictenidia BRULLÉ, Soc. Ent. France Ann. 2 (1833) 401. (Removed *bimaculata* Linnæus from the above Meigen list; subgenotype).

Cerocțena RONDANI, Dipt. Ital. Prodr. 1 (1856) 186; type *bimaculata.*

Dicera LIOY, Atti dell' Istitut Veneto (3) 9 (1863) 216; type *bimaculata.*

PSELLIOPHORA Osten Sacken

Pselliophora OSTEN SACKEN, Berlin, Ent. Zeitschr. 30 (1886) 165–166; subgenotype, *læta* Fabricius (designated by Brunetti, 1912; Enderlein, 1912).

PHOROCTENIA Coquillett

Phoroctenia COQUILLETT, U.S. Nat. Mus. Proc. 37 (1910) 589; subgenotype, *Ctenophora vittata angustipennis* Loew (western Nearctic Region).

Malpighia ENDERLEIN, Zool. Jahrb., Syst. 32 (1912) 18–19, *figs. C. D.* (antennæ); type, *Ctenophora vittata vittata* Meigen (Palæarctic Region).

It may be noted that Latreille in 1805 removed *atrata* from the original list of species included in *Ctenophora* by Meigen to become the type of *Tanyptera.* In 1810 he suppressed the name *Tanyptera* and designated *atrata* as type of *Ctenophora,* an unwarranted procedure in the light of his previous action.

(4). CTENOPHORA (CTENOPHORA) ISHIHARAI Alexander. **Plate 1, figs. 1, 2.**

IYO: Omogo Valley, August 23, 1953 (*Edashige*); Mount Takanawa, altitude 960 meters, August 14, 1953 (*Kusunoki*).

TOSA: Mount Kajigamori, altitude 700 meters, July 30, 1953 (*Edashige*).

The above specimens show a slight range in size (*Female.*– Length, 18 to 20 millimeters; wing, 12 to 14). The venation of the female is shown (Plate 1, fig. 1), the antenna (Plate 1, fig. 2).

211. **CTENOPHORA (CTENOPHORA) NOHIRÆ Matsumura.**

Ctenophora Nohiræ MATSUMURA, Thous. Ins. Japan Addit. 2 (1916) 451–453, *pl. 24, fig. 14* (whole ♂).

Cnemoncosis hilgendorfi ENDERLEIN, Zool. Anzeig. 52 (1921) 219–220.

Cnemoncosis nohiræ ESAKI, et al., Icon. Insect, Japan. Ed. 2 (1950) 1531, *fig.*

Matsumuras' type of *Nohiræ*' a male, was collected in the vicinity of Kyoto by Akio Nohira. Enderlein's type of *hilgandorfi* was from an unspecified locality in Japan, taken by Dr. Franz Hilgendorf. It should be noted that the enlargement of the basal part of the posterior tibia occurs in both sexes though less developed in the female than in the male.

IYO: Mount Sara (Saragamine), altitude 1,250 meters, July 25, 1953 (*Kusunoki*).

212. **CTENOPHORA (PSELLIOPHORA) SEPTENTRIONALIS (Alexander).**

Pselliophora septentrionalis ALEXANDER, Insec. Inscit. Menst. 9 (1921) 182–183.

The holotype was from Teshio, Hokkaido, taken July 12, 1916, by Issiki; a paratype from Lake Chuzenji, Honshu, taken July 21, 1910, by Edmonde Henri Gallois.

IYO: Mount Takanawa, altitude 960 meters, August 14 and 15, 1953 (*Kusunoki*).

The relationship of this fly to *Ctenophora isshikii* Matsumura, 1916, described from Odaigahara, Yamato, Honshu, remains in question and the two flies may well prove to be identical. Matsumura's type was a female whereas I have never seen anything but males of the present fly. *C. isshikii* has the antennæ yellow; præscutum shiny dark brown, with two indistinct fulvous stripes, presumably representing the interspaces; scutellum fulvous with a brown central spot. In the present fly the antennal flagellum beyond the basal segment is uniformly black; thorax fulvous yellow with the notum only a trifle darker.

213. **CTENOPHORA (TANYPTERA) FLAVOPOSTICATA Alexander. Plate 1, figs. 3, 4.**

Tanyptera flavoposticata ALEXANDER, Shikoku Ent. Soc. Trans. 4 (1954) in press.

Size relatively small (wing, 12 millimeters or less); general coloration black; halteres yellow; femora yellow, the tips abruptly black; tibiæ brown, the posterior pair with a broad yellow subterminal ring; wings yellow, the outer radial field strongly infuscated; vein R_{1+2} preserved; abdomen yellow, the tergites trivittate with black, the sternites more extensively blackened; male hypopygium with the outer dististyle short and massive, its

inner margin with about five teeth; inner dististyle a little larger, narrowed into a point, the lower beak a strong blackened spine.

Male hypopygium (Fig. 4) with the outer dististyle, *d*, short and massive its inner margin with about five teeth, the outermost longest. Inner dististyle slightly larger, extended into a narrow point, the lower beak a strong blackened conical spine.

The wing is shown (Fig. 3).

Male.—Length, about 11 to 12 millimeters; wing, 10 to 12; antennæ, about 3.3 to 3.5.

Female.—Length, about 13 millimeters; wing, 11 to 12.

IYO: Omogo Valley, altitude 700 meters, April 26 and 27, 1953 (*Yano*).

214. **TIPULA (BILLARDINA) AMPLIATA Alexander.** **Plate 1, fig. 5.**

Tipula ampliata ALEXANDER, Ann. and Mag. Nat. Hist. (9) 15 (1925) 394–395.

The type of this uncommon species was from Gokanosho, Higo, Kyushu, altitude 1,000 to 3,000 feet, taken May 3, 1924, by H. Hori.

IYO: Mount Ishizumi, altitude 1,200 meters, May 17, 1953 (*Ishihara*).

Male hypopygium (Plate 1, fig. 5) with the ninth tergite, *9t*, transverse, its posterior border conspicuously toothed, including shorter lateral spines and a central plate whose outer margin is produced into still larger slender rods, the median area weakly produced and carinate. Outer dististyle, *d*, a clavate or foot-shaped pale blade, at the apex or toe with numerous conspicuous black setæ. Inner dististyle irregular in outline, the beak relatively stout; outer basal lobe a powerful flattened more sclerotized blade, its apex obtusely rounded; lower margin with abundant short erect dark-colored setæ; outer margin at base with very long pale setæ.

(142). **TIPULA (SCHUMMELIA) ACIFERA Alexander.** **Plate 1, figs. 6, 7.**

IYO: Dogo, near Matsuyama, August 23, 1953 (*Yano*).

Wings (Plate 1, fig. 6) with Rs gently arcuated, a little longer than the straighter R_{2+3}; cell 1st M_2 unusually small, the veins beyond it proportionately long; cell M_1 deep, about twice its petiole; m-cu just beyond midlength of M_{3+4}.

Male hypopygium (Plate 1, fig. 7) with the tergite, *9t*, distinctive, the central portion of the posterior border produced into a terete rod that narrows gradually to the nearly acute tip, the

surface with microscopic appressed setulæ; immediately ventrad of this projects a stouter glabrous blade, its tip very obtuse (drawn to the side for clarity). Outer dististyle, *d*, a small pale blade, broadest about opposite one-third the length, the apex obtuse. Inner dististyle with the beak produced, the lower margin, together with the obtuse lower beak heavily blackened; posterior end of style produced backward into an oval blade, with long setæ that are directed backward.

215. TIPULA (SCHUMMELIA) ACIROSTRIS Alexander. **Plate 1, figs. 8, 9,**

Tipula (*Schummelia*) *acirostris* ALEXANDER, Shikoku Ent. Soc. Trans. 4 (1954) in press.

General coloration of præscutum yellow with three dark brown stripes; antennæ relatively short, flagellum black; pleura variegated dark brown and yellow; femora yellow, the tips conspicuously black; wings weakly infuscated, patterned with whitish and darker clouds; cell 1st M_2 small, cell M_1 long-petiolate; abdominal tergites dark brown, the more basal ones with the incisures pale; male hypopygium with the posterior border of the tergite very shallowly emarginate, the lobes correspondingly low, on ventral margin of each lobe with a small blackened tooth; inner dististyle a very flattened blade, the lower margin at near two-thirds the length with an unusually slender rostrum, the apex of style broadly rounded.

Male.—Length, about 11 to 12 millimeters; wing, 12 to 13.8; antenna, about 4 to 4.2.

Wings (Plate 1, fig. 8) with the ground weakly infuscated, patterned with restricted whitish areas and darker clouds; the white marks occur before and beyond the dark brown stigma, across cell 1st M_2, near outer end of cell 1st M_2, and as a marginal spot in cell 1st A near vein 2nd A; the darker clouds are chiefly in the outer radial field, at and near the fork of M_{+2}, and over m-cu; veins dark brown, lighter in the pale areas. Venation: Petiole of cell M_1 relatively long, fully one-fourth the cell; cell 1st M_2 small; m-cu just before fork of M_{3+4}.

Male hypopygium (Plate 1, fig. 9) with the tergite, *9t*, transverse, its posterior border very shallowly emarginate, the lobes correspondingly low; on ventral surface of each lobe just back from the margin with a small blackened tooth. Outer dististyle, *d*, narrow, broadest near base, tapering gradually to the obtuse tip. Inner dististyle a very flattened blade, bearing on its lower margin at near two-thirds the length an unusually slender M^{1+2} and over m-cu; veins dark brown, lighter in the pale

rostrum; apex of style broadly rounded, the surface with relatively few setæ.

IYO: Omogo Valley, August 3, 1952 (*Kusunoki*); Mount Ishizuchi, summit, altitude 1,931 meters, August 18, 1953 (*Chûjô*).

216. TIPULA (SCHUMMELIA) OMOGICOLA Alexander. Plate 1, fig. 10; Plate 2, fig 15.

Tipula (*Schummelia*) *omogicola* ALEXANDER, Shikoku Ent. Soc. Trans. 4 (1954) in press.

Allied to *macrotrichiata*; general coloration of thorax brownish gray, the præscutum with three scarcely darker brown stripes; antenna (male) elongate, flagellar segments bicolored; femora yellow, the tips narrowly dark brown; wings pale brownish or grayish yellow, the prearcular and costal fields more saturated yellow; narrow pale brown seams over the cord; sparse macrotrichia in outer end of cell R_5; cell 1st M_2 small, narrowed outwardly, m short to entirely obliterated; m-cu long, at fork of M; abdomen with basal three segments yellow, the outer ones brown; hypopygium brownish black, the posterior border of the ninth tergite produced caudad into a setiferous compressed blade; inner dististyle with the blade broad but relatively high.

Male.—Length, about 8 to 8.5 millimeters; wing, 10 to 11; antenna, about 5.

Wings (Plate 1, fig. 10) with the ground pale brownish or grayish yellow, the prearcular and costal fields more saturated yellow; stigma long-oval, dark brown, conspicuous; outer radial cells more conspicuously darkened; narrow pale brown seams over the cord, including m-cu; cells before cord slightly darker than those immediately beyond; obliterative areas before and beyond stigma and along the cord; veins brown, clear yellow in the flavous fields. Sparse macrotrichia in outer end of cell R_5, in cases with three or four further trichia in extreme outer ends of cells R_3 and M_1. Venation: Rs relatively long, gently arcuated; cell 1st M_2 small, narrowed outwardly, m short to entirely obliterated; m-cu long, oblique, at the fork of M.

Male hypopygium (Plate 2, fig. 15) with the posterior border of the ninth tergite, *9t*, produced caudad into a compressed blade, the sides of which bear dense long setæ; lateral lobes of tergite somewhat produced, obtuse. Outer dististyle, *d*, broadest beyond base, the tip obtuse. Inner dististyle with the blade broad but relatively high, the beak simple, slender. Ædeagus slender, straight, narrowed to the apex.

IYO: Omogo Valley, June 2, 1953 (*Mohri*); June 6, 1952 (*Yano*); May 31, 1953 (*Edashige*).

217. TIPULA (SCHUMMELIA) ESAKIANA Alexander. Plate 1, fig. 11; Plate 2, fig. 16.

Tipula (*Schummelia*) *esakiana* ALEXANDER, Philip. Jour. Sci. 51 (1933) 507–509, *pl 1, fig. 1* (venation), *pl 2, fig. 23* (♂ hypopygium).

The type of this very small member of the subgenus was from Sobosan, Bungo, Kyushu, collected July 13, 1931, by Esaki and Fujino.

IYO: Dogo, near Matsuyama, October 14, 1952 (*Yano*).

The present material adds to our knowledge of this uncommon fly and a re-description and new figures are furnished.

Male.—Length, about 7 millimeters; wing, 8; antenna, nearly 5.

Frontal prolongation of head yellow above, brown on sides and beneath; nasus distinct; palpi with basal two segments testaceous yellow, the outer ones darker. Antenna long; scape and pedicel yellow; first flagellar segment yellow, the succeeding ones bicolored, yellow, the small basal enlargements dark brown. Front whitened, the vertex light brown; vertical tubercle very low and inconspicuous.

Pronotum buffy, narrowly darkened medially. Mesonotal præscutum brownish yellow with a brown central stripe, the lateral stripes small and relatively inconspicuous; posterior sclerites of notum brown, sparsely pruinose, the scutal lobes patterned with brown. Pleura whitened, variegated with pale brown on the ventral anepisternum, sternopleurite and meron. Halteres with stem yellow, knob infuscated, the apex restrictedly paler. Legs with the coxæ whitened, the posterior pair a little infuscated basally; trochanters pale yellow; femora yellow basally, outwardly becoming more obscure, the tips passing into brown; tibiæ pale brown, narrowly darkened at tips; tarsi brown. Wings (Plate 1, fig. 11) weakly infuscated, more conspicuously so in the outer radial cells; cells C and Sc slightly darkened; stigma long-oval, darker brown, preceded and followed by whitened areas; obliterative markings at cord restricted in size, inconspicuous; veins brown, paler in the brightened areas. No macrotrichia in wing cells. Venation: Rs longer than R_{2+3}, only moderately arcuated; cell 1st M_2 small, pointed at outer end, m punctiform or obliterated; m-cu at near midlength of M_{3+4}; cell M_1 nearly twice its petiole; cell 2nd A narrower than in *acifera*.

Abdominal tergites brownish yellow, the posterior and lateral borders of the segments narrowly brown; sternites yellow, the posterior margins less distinctly darkened; hypopygium brown-

ish yellow. Male hypopygium (Plate 2, fig. 16) with the median region of the posterior border of the ninth tergite, *9t*, produced caudad into a relatively narrow lobe, the dorsal surface with a median furrow; sides of the lobe with conspicuous erect coarse setæ. Outer dististyle, *d*, relatively small, broadest before mediength, the apex obtuse. Inner dististyle unusually high, the outer end obtusely rounded, with coarser and more blackened setæ than else-where on style; rostrum more or less deflexed, blackened.

As was indicated at the time of the original description, this fly bears a striking superficial resemblance to *Tipula* (*Schummelia*) *acifera* Alexander, which is re-described in the present report. The male hypopygia of the two flies are entirely different.

218. TIPULA (ACUTIPOLA) BUBO Alexander.

Tipula bubo ALEXANDER, N.Y. Ent. Soc. Journ. 26 (1918) 69–70.
Tipula (*Acutipula*) *bubo* ALEXANDER, Philip. Jour. Sci. 57 (1935) 109.
Tipula bubo ESAKI, et al., Icon. Insect. Japon, Ed. 2 (1950) 1535, *fig.*

The type was from Akakura, Echigo, Honshu, taken August 6, 1914, by Nohira. The species is wide-spread in Japan, Korea and eastern Siberia (Okeanskaja, recorded by Masaki, 1933).

IYO: Omogo Valley, August 3, 1952 (*Kusunoki*).

219. TIPULA (OREOMYZA) HARUTAI Alexander.

Tipula (*Oreomyza*) *harutai* ALEXANDER, Ent. Soc. America Ann. 48 (in press).

The type was from Mount Takao, Musashi, Honshu, taken May 5, 1950, by T. Haruta.

IYO: Omogo Valley, April 25, 1953 (*Edashige*); Mount Takanawa, altitude 850 meters, May 8, 1953 (*Takechi*).

The male from Omogo Valley is unusually small but undoubtedly conspecific (Length, about 11 mm; wing, 14 mm).

220. TIPULA (OREOMYZA) KIUSHIUENSIS Alexander.

Tipula kiushiuensis ALEXANDER, Ent. Soc. America Ann. 17 (1924) 444–445.
Tipula (*Oreomyza*) *kiushiuensis* ALEXANDER, Philip. Jour. Sci. 57 (1935) 122.

The types were from Mount Kirishima, on the boundary between Osumi and Hiuga, Kyushu, altitude 3,250 feet, taken October 30, 1923, by Esaki.

IYO: Mominoki, Saragamine, altitude 700 to 800 meters, November 15, 1953 (*Yano*). Associated in nature with *Tipula* (*Oreomyza*) *koreana* Alexander.

The structure of the male hypopygium readily separates these two flies. In *kiushiuensis,* the inner dististyle is chiefly yellow, with a high pale dorsal crest. Eighth sternite sheathing, the apex obtuse, with relatively few and scattered long pale setæ. In *koreana,* the inner dististyle is entirely black, including the dorsal crest. Eighth sternite sheathing, tapering to the narrowly obtuse tip which bears a dense brush of shorter fulvous setæ. There are further conspicuous differences in the two flies involving almost every structure of the hypopygium. *T.* (*O.*) *mohriana* Alexander, which is likewise a member of the *marmorata* group, is entirely distinct.

221. TIPULA (OREOMYZA) KOREANA Alexander.

Tipula (*Oreomyza*) *koreana* ALEXANDER, Philip. Jour. Sci. 55 (1934) 33–35, *pl. 1, fig. 8* (venation), *pl. 2, fig. 31* (♂ hypopygium).

Described from Kongo San, Diamond Mountains, Korea, taken in October, 1933, by Machida.

IYO: Omogo Valley, November 12, 1953 (*Mohri*); Mominoki, Saragamine, altitude 700 to 800 meters, November 15, 1953 (*Yano*).

The present fly is still another of the increasing list of Tipulidæ and allied families that was originally described from Korea and are now recorded from Japan. Several of these are known in Japan only from Shikoku, including *Trichocera mirabilis* Alexander, *Limonia* (*Dicranomyia*) *kongosana* Alexander, and *Limnorimarga limonioides* (Alexander), but it seems certain that all of these will later be found in Honshu, as perhaps on Mount Daisen, in Hibi.

222. TIPULA (OREOMYZA) KUSUNOKIANA sp. nov. **Plate 2, fig. 12.**

General coloration of head and thorax light gray, the mesonotum patterned with darker, including a narrow central darkened vitta; conspicuous setigerous punctures on præscutal interspaces; legs black; wings very pale yellow, patterned with brown and black, including the uniformly blackened cells C and Sc; tip of vein R_{1+2} atrophied; abdomen obscure yellow, both the tergites and the sternites with a central darkening on the more proximal segments; cerci slender, straight.

Female.—Length, about 15 to 16 millimeters; wing, 13 to 13.5; antenna, about 1.6.

Frontal prolongation of head brownish black, heavily light gray pruinose above, including the long nasus; palpi black. Antennæ with scape relatively short, gray; pedicel brownish yellow, flagellum black, the extreme apex of the more proximal

segments paler; flagellar segments with the basal enlargements scarcely evident, a little more so on the outer ones; longest verticils a trifle exceeding the segments. Head clear light gray, vaguely patterned with darker, including a capillary line on the posterior vertex and broader postorbital areas; vertical tubercle hemispherical in shape, conspicuous.

Pronotum light gray, darkened medially. Mesonotal præscutum light gray, patterned with darker, including three vaguely differentiated darker gray stripes that are bordered by blackish, the most conspicuous marks being the anterior outer borders and a capillary central stripe that is very narrow on the anterior half of sclerite, widened behind; lateral stripes even less evidently bordered by darker; setigerous punctures of interspaces conspicuous, brownish black; posterior sclerites of notum similarly light gray, the dark central præscutal stripe continued across the suture and including the central parts of the scutum and scutellum, on the mediotergite much narrower; scutal lobes patterned with paler brown. Pleura and pleurotergite clear light gray, unpatterned; dorsopleural membrane vaguely more yellowed. Halteres yellowish brown, the knobs dark brown. Legs with the coxæ light gray; trochanters darker brownish gray; remainder of legs entirely black, the femora more intensely so. Wings (Plate 2, fig. 12) with the ground very pale yellow, slightly deeper yellow in the posterior prearcular cells; costal border, including cells C and Sc, black, confluent with the stigma; elsewhere on wing with a slightly paler dark brown pattern, including the outer end to just beyond the apex; narrower areas at origin of Rs, along cord, and as a cloud in cell M adjoining vein Cu; paler gray clouds in Anal cells and as a vague crossband in cells R, M and Cu at the level of the darkened area in cell M; very narrow darkened seams on outer medial veins; veins light yellow in the clear parts, including both Anal veins, blackened in the patterned portions. Venation: Rs about twice m-cu; outer half of vein R_{1+2} atrophied; cell M_1 more than twice its petiole; cell 1st M_2 narrowed outwardly, m being the shortest element enclosing the cell; m-cu on M_4 just beyond the perpendicular base.

Abdominal tergites obscure yellow, with a conspicuous median brown stripe that narrows behind, becoming obsolete on about the sixth segment; sternites with a similar stripe, very extensive on the basal segments. Ovipositor with the cerci straight, slender; hypovalvæ much shorter but deeper, compressed, the tips obtuse.

Habitat.—Japan (Shikoku).

Holotype, female, Mount Saragamine, Iyo, altitude 1,000 meters, July 26, 1952 (*Kusunoki*). Paratype, female, Mount Takanawa, Iyo, altitude 960 meters, August 15, 1953 (*Kusunoki*).

I am pleased to dedicate this interesting crane-fly to Mr. Hiroyuki Kusunoki, who has added many interesting records to the Shikoku list, particularly from Mounts Saragamine and Takanawa. Other regional members of the subgenus having the costal border of the wings narrowly blackened include *Tipula* (*Oreomyza*) *nigrocostata* Alexander, *T.* (*O.*) *strix* Alexander, and some others, all of which differ from the present fly in all details of coloration of the body, legs and wings. The uniformly blackened legs of the present species are noteworthy.

223. TIPULA (OREOMYZA) MOHRIANA Alexander. Plate 2, figs. 13, 19.

Tipula (*Oreomyza*) *mohriana* ALEXANDER, Shikoku Ent. Soc. Trans. 4 (1954) in press.

Belongs to the *marmorata* (*fragilis*) group; size large (wing, male, 17 millimeters); general coloration of mesonotum dull gray, the præscutum with four brown stripes; femora obscure yellow, the tips abruptly blackened; wings very pale gray, vaguely patterned with whitish spots, the stigma darker brown; abdomen yellow, the outer segments dark brown; male hypopygium with the outer dististyle long and narrow, with a blackened marginal tooth near base; gonapophysis a slender curved black spine; eighth sternite produced into two relatively narrow lobes that are separated by a broad U-shaped notch.

Male.—Length, about 15 millimeters; wing, 17; antenna, about 4.

Female.—Length, about 18 millimeters; wing, 18.

Male hypopygium (Plate 2, fig. 19) with the ninth tergite, *9t*, produced into two slender lobes that are very strongly divergent, on a microscope slide appearing virtually at a straight angle; posterior border between the lateral lobes with a few blackened spicules. Basistyle with a blackened flange on mesal face. Outer dististyle, *d*, long and narrow, the dorsal edge near base with a blackened tooth. Inner dististyle with the beak very small. Gonapophysis, *p*, appearing as a slender curved black spine; on either side of phallosome with a broadly flattened pale lobe. Eighth sternite, *8s*, at outer end produced into two relatively narrow lobes that are separated by a broad V-shaped notch.

The wing is shown (Plate 2, fig. 13).

Iyo: Mount Ishizuchi, altitude 1,600 to 1,800 meters, October, 1952 (*Mohri*).

The species was named in honor of Mr. Terunori Mohri.

224. **TIPULA (OREOMYZA) NIGROCOSTATA** Alexander. **Plate 1, figs. 14, 20.**

Tipula nigrocostata Alexander, Ent. Soc. America Ann. 17 (1924) 445–446.

Tipula sakaguchiana Alexander, Philip. Jour. Sci. 51 (1933) 379–381, *pl. 1, fig. 7* (venation), *pl. 2, fig. 32* (♂ hypopygium).

The types of *nigrocostata* were from various stations in Kyushu, taken in October and November. The type of *sakaguchiana* was from Kii, Honshu, taken in August, 1929, by Sakaguchi. In the light of the further material now available, I consider the two flies as being conspecific, or, at most, the latter form representing a weak, more northern cline of the typical form.

Iyo: Omogo Valley, September 28, 1952 (*Yano*).

The wing is shown (plate 2, fig. 14).

Male hypopygium (Plate 2, fig. 20) relatively small, the tergite, sternite and basistyle separated by complete sutures. Viewed from the side, the blackened tergal disk appears about as shown, the posterior spines being directed dorsad and very slightly caudad; the median pale membrane is elevated into a compressed bladelike area. Ninth tergite, *9t*, including a cephalic or posterior portion that is completely divided into two halves by pale membrane; outer tergal disk blackened on either side, separated by pale membrane, as described above; each outer lobe expanded, divided into two lobules by a small notch; cephalic end of the blackened plate produced into a spine, as described. Basistyle, *b*, strongly produced, the lobe narrowed gradually to the obtuse tip; surface of lobe with very abundant elongate setæ. Outer dististyle, *d*, a pale club, slightly enlarged outwardly. Inner dististyle pale, the beak a compressed-flattened circular blade; disk of main body of style produced into a flattened flange. Ædeagus, *a*, small and simple; gonapophyses so reduced as to be virtually lacking. Eighth sternite, *8s*, short-transverse, the posterior border nearly truncate, with pale membrane; provided with numerous black setæ of moderate length.

225. **TIPULA (OREOMYZA) OTIOSA** Alexander. **Plate 2, figs. 17, 18.**

Tipula otiosa Alexander, Ann. and Mag. Nat. Hist. (9) 14 (1924) 467–469.

Tipula (*Oreomyza*) *otiosa* Alexander, Philip. Jour. Sci. 57 (1935) 122.

The types were from Mount Takao, Musashi, Honshu, altitude 1,000 to 2,000 feet, taken April 13, 1923 by Esaki.

IYO: Omogo Valley, altitude 700 meters, April 25, 1953 (*Edashige* and *Yano*); Mominoki, Saragamine, altitude 650 to 800 meters, May 17, 1953 (*Yano*).

The wings of the present specimens are somewhat more heavily patterned than in the types, the whitened areas especially being somewhat more conspicuous. The peculiar ovipositor (Plate 2, fig. 18) has not been described. Cerci very long and slender, their bases swollen and provided with long yellow setæ, the outer part of the structure long and slender, decurved to the narrowly obtuse tips. Hypovalvæ stout, their bases with numerous setæ, the tips broadly obtuse. Male hypopygium (Plate 2, fig. 17) with the tergite, *9t*, transverse, its posterior border with a broad shallow median notch, the low lateral lobes with almost the same outline; midline of dorsal surface with a narrow furrow; posterior border at base of the notch beneath with a small obtuse lobule. Outer dististyle, *d*, an elongate pale blade, broadest at near midlength, thence narrowed to the obtuse tip, the length about four times the breadth. Inner dististyle with the base expanded, constricted at near midlength, thence dilated, the beak slender; lower beak a flattened blade, its apex obtuse.

226. **TIPULA (OREOMYZA) STRIX Alexander.**

Tipula strix ALEXANDER, N.Y. Ent. Soc. Jour. 26 (1918) 71.

Tipula (*Oreomyza*) *strix* ALEXANDER, Philip. Jour. Sci. 57 (1935) 123.

The type was from Tokuhara, Shinano, Honshu, collected August 31, 1915, by Nohira.

IYO: Joju, Mount Ishizuchi, August 17, 1953 (*Chûyô*); Onagahara, August 6, 1952 (*Kusunoki*); Mominoki, altitude 700 meters, September 6, 1953 (*Yano*); Mount Saragamine, altitude 1,200 meters, July 24, 1953 (*Kusunoki*); Mount Takanawa, altitude 960 meters, August 14 and 15, 1953 (*Kusunoki*).

In some of the present specimens the blackened tips of the fore femora are more extensive than in the type, including the outer two-thirds of the segment.

227. **TIPULA (OREOMYZA) TRUPHEONEURA Alexander.**

Tipula trupheoneura ALEXANDER, Amer. Ent. Soc. Trans. 46 (1920) 17–18.

Tipula trupheoneura ALEXANDER, Philip. Jour. Sci. 51 (1933) 391–392, *pl. 4, fig. 43* (♂ hypopygium).

Tipula (*Oreomyza*) *trupheoneura* ALEXANDER, Philip. Jour. Sci. 57 (1935) 123.

The type was from Musashi (Saitama), Honshu, taken May 31, 1919, by Takahashi.

Iyo: Omogo Valley, altitude 800 meters, May 4, 1952 (*Ide*).

228. **NEPHROTOMA REPANDA** (Alexander). **Plate 3, figs. 21, 22.**

Pachyrhina repanda Alexander, Can. Ent. 46 (1914) 162–163, *pl. 11, fig. 3* (venation), *fig. 11* (antennal segment), *figs. 8, 16* (♂ hypopygium).

The type was taken in the vicinity of Tokyo in August, 1912.

Iyo: Mount Saragamine, altitude 1,100 meters, June 27, 1952 (*Ide*), altitude 1,200 meters, July 25, 1953 (*Kusunoki*).

The original description is faulty and deficient in certain respects and is replaced by the following account.

Male.—Length, about 12 to 13.5 millimeters; wing, 11.5 to 14; antenna, about 5 to 5.5.

Frontal prolongation of head polished yellow; nasus elongate, darker; palpi obscure yellow, the intermediate segments more obscure. Antennæ (male) relatively long, exceeding one-third the wing; proximal three segments yellow, succeeding flagellar segments weakly bicolored, the conspicuous basal enlargements dark brown, the remainder of segment brownish yellow; outer segments uniformly darkened; intermidate segments strongly incised, the outer swelling longer and almost as deep as the basal enlargement; segments about equal in length to the longest verticils. Head dull orange, weakly darkened on anterior orbits; vertical tubercle protuberant, entire; occipital brand not or scarcely indicated.

Pronotum orange, paling to yellow on sides. Mesonotal præscutum yellow with three polished black stripes, the cephalic and posterior borders of the central stripe, spot at anterior end of lateral vitta, and outer ends of suture more velvety black, the lateral stripes thus appearing outcurved; remainder of notum yellow, each scutal lobe with a major polished black area that is narrowly bordered internally with velvety black; mediotergite and pleurotergite more orange, the former vaguely darker on posterior fourth. Pleura orange yellow; dorsopleural membrane more yellowed. Halteres obscure yellow, the knobs weakly darkened. Legs with the coxæ and trochanters yellow; remainder of legs obscure yellow or brownish yellow, the tarsi passing into brownish black; claws (male) toothed. Wings (Plate 3, fig. 21) grayish yellow; stigma brown, with relatively numerous trichia on proximal half; veins dark brown. Venation: Sc_2 ending opposite or just beyond origin of Rs, the latter straight, about one-half longer than basal section of R_{4+5}; cell

M_1 barely to more broadly sessile; m-cu at fork of M or just beyond this on the base of M_4.

Abdominal tergites yellow, more or less distinctly trivittate with dark brown, the central stripe beginning on the second segment, in cases paler to barely indicated; lateral stripes more distinct; basal sternites yellow. Male hypopygium (Plate 3, fig. 22) with the ninth tergite, *9t*, transverse, the posterior border produced into four broad lobes that are provided with abundant spiculose points; lateral lobes unusually broad for a member of this genus, expanded outwardly. Outer dististyle, *d*, short, about two and one-half times as long as broad, narrowed to the obtuse tip. Inner dististyle short and compact; beak slender; no well-developed dorsal or posterior crests. Phallosome, *p*, with the gonapophyses small, suboval, their tips rounded, shorter than the broad-based ædeagus. Eighth sternite, *8s*, moderately sheathing, the posterior border entire, membranous, with very abundant long yellow setæ of moderate length; setæ elsewhere on sclerite more scattered, shorter and darker.

LIMONIINAE

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229. LIMONIA (LIMONIA) GLOBITHORAX GLOBULITHORAX (Alexander).

Dicranomyia globithorax OSTEN SACKEN, Monog, Dipt. N. Amer. 4 (1869) 74–75.

Dicranomyia globulithorax ALEXANDER, Philip. Jour. Sci. 24 (1924) 547–548.

The subspecies was described from Lake Shikotsu, Hokkaido, taken September 27, 1922, by Esaki.

IYO: Mominoki, altitude 700 meters, September 6, 1953 (*Yano*).

The present fly is exceedingly close to typical *globithorax* and may prove to be identical. The typical form is known only from the eastern Nearctic Region, as far west as Michigan and Wisconsin; the present fly is known only from Hokkaido and Shikoku. No representatives of the species are known at the present time from the intervening area.

230. LIMONIA (LIMONIA) INELEGANS Alexander.

Limonia inelegans ALEXANDER, Insec. Inscit. Menst. 12 (1924) 156–157.

Described from various stations in Hokkaido and Honshu, collected in 1923 by Esaki. Also known from the high mountains of Formosa and eastern China, as far west as Mount Omei, Szechwan.

Iyo: Mount Ogawamine, altitude 700 meters, August 1, 1953 (*Ide*).

231. **LIMONIA (LIMONIA) NEONEBULOSA (Alexander).**

Dicranomyia nebulosa Alexander, Can. Ent. 45 (1913) 203–205, *pl. 3, fig. 10* (wing), *pl. 4, figs. 8–9* (♂ hypopygium); name preoccupied.

Limonia neonebulosa Alexander, Philip. Jour. Sci. 24 (1924) 555–556.

Limonia neonebulosa Esaki, et al., Icon. Insect. Japon. Ed. 2 (1950) 1515, *fig.*

A well-known species in Karafuto, Hokkaido and Honshu, likewise occuring in eastern China as far west as Szechwan. Very recently it has been discovered in northeastern North America (Amherst, Massachusetts, October, 1952, 1953) and will probably be found to have a much wider distribution than is known at present. It is chiefly a late season species which may account for its failure to be found in United States until such a recent date. Most collecting is done in the spring and summer and there is a tapering off of such activities later in the season.

Iyo: Mount Onagahara, August 5, 1952 (*Kusunoki*).

232. **LIMONIA (LIMONIA) OCHRIPES sp. nov.** **Plate 3, figs. 23, 24.**

Size relatively small (wing, male, under 7 millimeters); mesonotum brown, with vague indications of three more brownish yellow stripes; antennæ black, the flagellar segments with short apical pedicels; thoracic pleura obscure yellow with a broad dorsal brown stripe; halteres black; legs light brown, the outer ends of the tibiæ and the tarsi passing into obscure yellow; wings with a strong brownish tinge, restrictedly patterned with darker; Sc_1 ending shortly beyond midlength of Rs; cell 1st M_2 large, about as long as the distal section of vein M_{1+2}; male hypopygium with the dorsal dististyle a weak, virtually straight spine; ventral dististyle relatively small, its rostral prolongation long and conspicuous, with two long spines placed close together at its base.

Male.—Length, about 5.5 millimeters; wing, 6.8; antenna, about 1.2.

Rostrum obscure yellow; palpi black. Antennæ with the scape obscure yellow, remaining segments black; basal flagellar segments oval, with short abrupt apical pedicels, the outer segments becoming longer; terminal segment about one-third longer than the penultimate. Head obscure fulvous yellow; anterior vertex relatively broad, fully twice the diameter of the scape.

Pronotum light yellow above, the color continued backward to the wing-root, involving the dorsopleural region and the lateral

border of the præscutum, sides of pronotum brownish black. Mesonotal præscutum brown, with vague indications of three more brownish yellow stripes; posterior sclerites of notum brown, the scutellum a trifle more brightened. Pleura obscure yellow, with a broad dorsal brown stripe extending from the pronotum across the dorsal pleurites to the postnotum; ventral sternopleurite vaguely darkened. Halteres black. Legs with all coxæ yellow; trochanters a trifle darker; femora light brown; tibiæ light brown basally, paling to ochreous yellow outwardly); tarsi obscure yellow, the last segment black; claws long and slender, with a conspicuous basal spine. Wings (Plate 3, fig. 23) with a strong brownish tinge, restrictedly patterned with darker; stigma oval, brown; narrow, very inconspicuous seams over cord and outer end of cell 1st M_2; veins brown, those in the costal areas paler. Venation: Sc_1 ending shortly beyond midlength of Rs, Sc_2 near its tip, h very oblique; free tip of Sc_2 lying just proximad of R_2; cell 1st M_2 large, about as long as the distal section of M_{1+2}; m-cu close to fork of M; vein 2nd A long, very gently sinuous at near midlength.

Abdomen dark brown, the eighth segment a little paler; hypopygium dark brown, the styli paler. Male hypopygium (Plate 3, fig. 24) with the tergite, *9t*, large, its cephalic margin convex, the posterior border narrowly emarginate medially, the lobes obtusely rounded, each with about 10 or 11 very long setæ. Basistyle, *b*, with the ventromesal lobe simple, with long setæ. Dorsal dististyle, *d*, a weak, virtually straight rod that narrows very gradually to the acute tip. Ventral dististyle relatively small, its area much less than that of the basistyle; rostral prolongation very long, almost parallel-sided, the apex subtruncate, tipped with several strong setæ; at base of prolongation with two long slender rostral spines, placed close together; body of style with relatively few but very long setæ. Gonapophysis, *g*, with mesal-apical lobe a long simple blade, narrowed to the obtuse tip. Ædeagus relatively slender.

Habitat.—Japan (Shikoku).

Holotype, male, Mount Saragamine, Iyo, altitude 1,000 meters, July 4, 1953 (*Mohri*).

In its general appearance, the present fly is most as in *Limonia* (*Limonia*) *edura* Alexander and *L.* (*L.*) *yakushimensis* Alexander, differing in all details of coloration and in the structure of the antennæ and male hypopygium (this unknown for *edura*).

233. LIMONIA (METALIMNOBIA) BIFASCIATA FLAVOABDOMINALIS (Alexander).

Tipula bifasciata SCHRANK, Enum. Insect. Austr. (1781) 428.
Limnobia avis flavo-abdominalis ALEXANDER, Ent. Soc. America Ann. 11 (1918) 445.
Limnobia avis flavoabdominalis ALEXANDER, Ent. Mag. (Kyoto) 3 (1919) 123.

Described from an unknown locality in Honshu, collected by Nohira.

IYO: Mount Takanawa, August 15, 1953 (*Kusunoki*).

234. LIMONIA (LIBNOTES) NOHIRAI (Alexander).

Libnotes nohirai ALEXANDER, Ent. Soc. America Ann. 11 (1918) 445.
Libnotes nohirai ALEXANDER, Ent. Mag. (Kyoto) 3 (1919) 123–124.
Libnotes nohirai ESAKI, et al., Icon. Insect. Japon, Ed. 2 (1950) 1514, *fig.*

The type was from Iwate, Honshu, collected in June, 1916 by Akio Nohira. Known also from Kyushu.

IYO: Omogo valley, altitude 800 meters, October 17 to 20, 1952 (*Kusunoki*), November 9, 1953 (*Kusunoki*), November 9, 1953 (*Mohri*); Sugitate, near Matsuyama, November 3, 1953 (*Mohri*).

235. LIMONIA (DISCOBOLA) ANNULATA (Linnæus).

Tipula annulata LINNÆUS, Syst. Nat., Ed. 10 (1758) 586.
Limnobia argus SAY, Long's Exped. to St. Peters R., 2, Appendix (1824) 358.
Trochobola argus OSTEN SACKEN, Monog, Dipt. N. Amer. 4 (1869) 98–99, *pl. 1, fig. 4* (wing).
Discobola argus ALEXANDER, Crane-flies N.Y. 1 (1919) 892, pl. *32 fig. 41* (wing).
Dicranomyia sp., SAITO, Ent. World (76) 8 (1940) 379, *2 figs.* (wing).
Limonia (*Discobola*) *annulata* ALEXANDER, Dipt. Conn. 1 (1942) 309–310, *fig. 37*, A (♂ hypopygium).

Widespread throughout the Holarctic Region, in eastern Asia ranging southward into the high mountains of Luzon, Mindanao and Borneo, and probaly farther.

IYO: Mount Ishizuchi, summit, altitude 1,980 meters, August 18, 1953 (*Chûjô*).

236. LIMONIA (DISCOBOLA) FUMIHALTERATA sp. nov.

Size small (wing, female, 7.5 millimeters); mesonotal præscutum chiefly covered by three blackened sparsely pruinose stripes, the humeral region extensively obscure yellow; posterior sclerites of notum dull black; knobs of halteres conspicuously dark brown; femora weakly infuscated, with a broad black subterminal ring, preceded and followed by clear yellow, the latter one narrower;

wings with a faint yellow tinge, with an ocellate brown pattern, the margins of the rings narrow, the open centers correspondingly large; a few faint darkened spots in cell M.

Female.—Length, about 6.5 millimeters; wing, 7.5

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval. Head dark gray, anterior vertex reduced to a capillary strip; some strong erect setæ on cephalic portion of this strip opposite anterior part of eye.

Pronotum greenish testaceous. Mesonotal præscutum chiefly covered by three blackened, sparsely pruinose stripes, the humeral region extensively obscure yellow; posterior sclerities of notum black, sparsely pruinose. Pleura blackened on anterior part, including the propleura and anepisternum, the sternopleurite and mesepimeron paler. Halteres with stem white, knob conspicuously dark brown. Legs with the coxæ greenish testaceous; trochanters yellow; femora weakly infuscated, with a broad black subapical ring, the narrow tip and a broader subterminal ring clearer yellow; tibiae brown, the tips narrowly darker; tarsi brown, the tips brownish black. Wings with a faint yellow tinge, the prearcular and costal regions clearer yellow; a restricted brown pattern having the usual ocellate pattern as found in *annulata* and allies, the margins of the rings narrow, the open centers correspondingly large; a few faintly darkened spots in cell M; veins yellow, darker in the patterned areas. Venation: Sc_1 ending about opposite the fork of Rs, Sc_2 near its tip; m-cu very close to the fork of M.

Abdominal tergites dark brown, the sternites paler; genital shield yellow; cerci small, slender; hypovalvæ darkened basally.

Habitat.—Japan (Shikoku).

Holotype, female, Mount Takanawa, altitude 980 meters, October 24, 1953 (*Kusunoki*).

Distinguished from other regional members of the subgenus by the uniformly darkened knobs of the halteres and the very sparse brown dotting in cell M of the wings. In *annulata* there are no darkened spots in this cell while in *moiwana* Alexander and *parvispinula* Alexander, these are numerous and conspicuous.

237. **LIMONIA FUSCA Meigen.**

Limonia fusca MEIGEN, Klass. 1 (1804) 54.
Limnobia turpis WALKER, Ins. Saundersiana, Dipt. 3 (1856) 300.
Dicranomyia pubipennis OSTEN SAKEN, Acad. Nat. Sci. Philadelphia Proc. (1859) 211.
Limnobia pilipennis EGGER, Zool.-bot Ges. Wien Verh. 13 (1863) 1108.

Eurasia, eastern Nearctic Region; widely distributed throughout the North Temperate zone. In Japan first recorded from Hokkaido.

IYO: Omogo Valley, May 31, 1953 (*Mohri*).

238. **LIMONIA (DICRANOMYIA) BASIFUSCA (Alexander).**

Dicranomyia basifusca ALEXANDER, Ent. Soc. America Ann. 12 (1919) 328.

Dicranomyia atripleura ALEXANDER, Ent. Soc. America Ann. 12 (1919) 328–429.

The type of *basifusca* was from the vicinity of Tokyo, taken April 10, 1919 by Takahashi; that of *atripleura* from Chosi, Shimosa (Chiba), taken October 17, 1919, also by Takahashi. The types of both were represented by unique females and in the light of more abundant materials later received I do not consider them to be distinct. The fly is related to *Limonia* (*Dicranomyia*) *sordida* (Brunetti), differing in relatively slight hypopygial characters.

IYO: Omogo Valley, altitude 800 meters, July 14, 1952 (*Ishihara*), September 28, 1952 (*Yano*); Onogohara, August 5, 1952 (*Kusunoki*); Mount Saragamine, altitude 1,200 meters, July 24, 1953 (*Kusunoki*); Shiroyama, near Matsuyama, altitude 132 meters, July 24, 1953 (*Yano*).

239. **LIMONIA (DICRANOMYIA) KONGOSANA Alexander.**

Limonia (*Dicranomyia*) *kongosana* ALEXANDER, Philip. Jour. Sci. 55 (1934) 43–44, *pl. 1, fig. 14* (venation), *pl. 3, fig. 35* (♂ hypopygium).

The types were from Kongo San (Diamond Mountains), Korea, taken October 8 to 17, 1933, by Machida. The fly was not previously known from Japan. This is the largest known member af the *morio* group of the subgenus. It is most nearly allied to *Limonia* (*Dicranomyia*) *spinifera* Alexander, of the northeastern Nearctic Region, differing in the black color, conspicuously darkened stigma of the wings, and in slight details of structure of the male hypopygium.

IYO: Omogo Valley, November 9 to 12, 1953 (*Mohri*).

240. **LIMONIA (DICRANOMYIA) MODESTA (Wiedemann).**

Limnobia modesta WIEDEMANN, in Meigen, Syst. Beschr. 1 (1818) 134.

Dicranomyia takahashii ALEXANDER, Amer. Ent. Soc. Trans. 46 (1920) 2.

Dicranomyia spinicauda ALEXANDER, Philip. Jour. Sci. 24 (1924) 545–546, *pl. 1, fig. 5* (♂ hypopygium).

Dicranomyia takahasii ESAKI, et al., Icon Insect, Japon Ed. 2 (1950) 1517, *fig.*

The types of *takahashii* were from the vicinity of Tokyo; of *spinicauda* from various stations in Karafuto and Hokkaido. It is now known that the species has a virtually Holarctic range, being lacking only in the eastern Nearctic Region (though recorded from Greenland).

IYO: Maminomi, Mount Saragamine, altitude 700 to 800 meters. November 15, 1953 (*Yano*).

241. HELIUS (HELIUS) OBLITERATUS (Alexander).

Rhamphidia obliterata ALEXANDER, Amer. Ent. Soc. Trans. 46 (1920) 7–8.

The type was from Saitama, Honshu, collected May 29, 1919 by Takahashi.

IYO: Omogo Valley, altitude 800 meters, June 2, 1953 (*Mohri*).

242. DICRANOPTYCHA EDASHIGEANA sp. nov. **Plate 3, figs. 25, 26.**

General coloration of thorax reddish yellow, the posterior end of præscutum with two large polished black areas, the acutal lobes similarly patterned; pleura polished reddish yellow; legs stout, conspicuously hairy, yellow, the femoral tips, tibial bases and tips broadly blackened; wings with a strong blackish tinge, the base more yellowish brown, the forked fold in cell Cu conspicuously whitened against the dark ground; abdomen black; male hypopygium with the outer dististyle having spinulæ on outer third; two pairs of gonapophyses, the outer ones pointed at tips.

Male.—Length, about 8.5 to 9 millimeters; wing, 9.5 to 10.

Female.—Length, about 8 to 9 millimeters; wing, 9 to 10.

Rostrum reddish yellow; palpi dark brown. Antennæ with the proximal seven or eight segments yellow, the scape a trifle darker; outer flagellar segments darker, especially on the sligthly dilated basal portions; verticils elongate. Head brownish black, the front and cephalic part of anterior vertex obscure yellow; anterior vertex broad, nearly four times the diameter of the scape.

Pronotum yellow. Mesonotum reddish yellow, with four large polished black oval areas, one on either side of posterior part of præscutum, the other somewhat larger pair on the scutal lobes; scutellum more infuscated. Pleura polished reddish yellow. Halteres infuscated, the base of stem slightly paler. Legs with the coxæ and trochanters yellow, the posterior coxæ a trifle more darkened; femora yellow, the tips abruptly black; tibiæ yellow,

the broad base and the apex black; proximal two tarsal segments yellow, their tips blackened; outer tarsal segments uniformly black; legs stout, conspicuously hairy, the setæ generally concolorous with the part of leg that bears them, those of femora darkened but with the abundant linear scales pale. Wings (Plate 3, fig. 25) with a strong blackish tinge, the base vaguely more yellowish brown, the costal and apical parts more intensely blackened; whitened obliterative streaks in cell R near vein M, just behind vein 1st A, and as the usual forked fold in cell Cu; veins dark brown, paler in the basal portions. Venation: Sc_1 ending just beyond fork of Rs; cell 1st M_2 relatively small, shorter than vein M_4; m-cu about its own length beyond the fork of M.

Abdomen intensely black, including the genitalia of both sexes. Male hypopygium (Plate 3, fig. 26) with the outer dististyle, *d*, shorter than the inner dististyle, its apex acute, slightly decurved; outer third of style with very small erect spinulæ; inner style gently curved, slender, the basal half with large punctures, those of the apex smaller, with minute setæ. Interbase, *i*, a parallel-sided blade, its tip obtuse. Two pairs of gonapophyses, *g*, the outer ones longer, slightly dilated before the acute tip; inner apophyses with the tips obtuse.

Habitat.—Japan (*Shikoku*).

Holotype, male, Mount Kajigamori, Tosa, August 12, 1952 (*Edashige*). Allotopotype, female, pinned with type. Paratopotypes, 1 male, 2 females.

I am very pleased to dedicate this interesting species to the collector, Mr. Tadao Edashige, who has secured several interesting Tipulidæ. The only approximately similar species so far described is *Dicranoptycha geniculata* Alexander, of Formosa, which differs evidently in the coloration of the body, legs and wings and, especially, the very different male hypopygium. A further species of this attractive group has recently been discovered in the central Alps of Honshu and is being described elsewhere.

PEDICIINI

243. NIPPONOMYIA TRISPINOSA (Alexander).

Genus incertus (*Hexatomini*) BRUNETTI, Rec. Indian Mus. 15 (1918) 328.

Tricyphona trispinosa ALEXANDER, Amer. Ent. Soc. Trans. 44 (1920) 15.

Nipponomyia trispinosa ALEXANDER, Insec. Inscit. Menst. 12 (1924) 159.

Nipponomyia trispinosa ALEXANDER, Rec. Ind. Mus. 29 (1927) 202.
Nipponomyia trispinosa ESAKI, et al., Icon Insect, Japon Ed. 2 (1950) 1521, *fig.*

The type was from an unspecified locality in Honshu, collected by Nohira. Later recorded from several stations in Honshu, at low and moderate altitudes.

IYO: Mount Saragamine, altitude 800 meters, September 6, 1953 (*Yano*).

HEXATOMINI

244. EPIPHRAGMA (EPIPHRAGMA) TRICHOMERA sp. nov. Plate 3, figs. 27, 28.

Size small (wing under 10 millimeters); præscutum in front chestnut brown, the margins black, the posterior half of sclerite with four abbreviated dark brown stripes, the interspaces yellow pollinose; pleura dark brown, with narrow pruinose longitudinal stripes on ventral half; halteres with base of knob dark brown, the apex extensively pale yellow; legs yellow, the femora with a narrow vaguely indicated subterminal brown ring; wings whitish with an extensive brown pattern, the areas solidly darkened, pattern ocellate, chiefly confluent; m-cu opposite one-third the length of cell 1st M_2; male hypopygium with the tergal lobes very low; interbase a long sinuous very slender rod that narrows to the hairlike tip.

Male.—Length, about 9.5 millimeters; wing, 9.2.

Female.—Length, about 8.5 millimeters; wing, 8.

Rostrum brown; palpi black. Antennæ short; scape and pedicel black, fusion-segment of flagellum orange-yellow, succeeding flagellar segments light brown. Head above chestnut brown, the center of vertex darker brown.

Prothorax dark brown. Mesonotal præscutum in front chestnut brown, bordered laterally by black, behind with four abbreviated dark brown stripes, the interspaces yellow pollinose; scutum brown, the centers of the lobes extensively darker brown; scutellum dark brown, pruinose; mediotergite dark brown posteriorly, the cephalic half with a central brown area that is bordered behind by convergent gray lines. Pleura and pleurotergite dark brown, with narrow pruinose longitudinal stripes on the ventral half; dorsopleural membrane dark brown. Halteres with stem brownish yellow, base of knob dark brown, the apex extensively pale yellow. Legs with the coxæ dark brown, more or less pollinose; trochanters brownish yellow; femora obscure yellow, virtually unpatterned or with vague indications of a darker subterminal ring; tibiæ and tarsi obscure yellow,

the last tarsal segment a trifle darker. Wings (Plate 3, fig. 27) with the ground color whitish, with an extensive brown pattern, the areas solidly darkened or uniform in pattern, not with darkened margins and pale centers, as in *subfascipennis* and *subinsignis*; dark areas more extensive than the pale ground, chiefly ocellate in form but so extensive as to be chiefly confluent, particularly at and beyond the cord; in cases, a complete but narrow crossband of the ground at midlength of wing, this obliterated in the type; extensive pale marginal spots at ends of all the cells, including two in cell 2nd A; a yellow marginal area in cell Sc_1 above the stigma; veins brown in the patterned areas, more yellowed in the ground. Venation: R_{2+3+4} nearly straight, subequal to R_{2+3}; m-cu before midlength of cell 1st M_2, commonly near one-third the length of the cell.

Abdomen black, the posterior borders of the segments narrowly and vaguely pale, more expanded on sides; hypopygium brown. Male hypopygium (Plate 3, fig. 28) with the tergite, *9t*, very shallowly emarginate medially, the lobes very low. Interbase, *i*, a long sinuous very slender rod, narrowed very gradually to the acute hairlike tip. Outer dististyle, *d*, relatively narrow, the slender tip decurved; inner style longer, the tip obtuse.

Habitat.—Japan (Shikoku).

Holotype, male, Mount Saragamine, Iyo, altitude 1,200 meters, July 25, 1953 (*Kusunoki*). Allotopotype, female, with the type. Paratype, female, Omogo Valley, Iyo, altitude 800 meters, August 7, 1953 (*Yano*).

The most similar regional species is *Epiphragma* (*Epiphragma*) *evanescens* Alexander, which differs in details of coloration and in the structure of the male hypopygium, particularly the interbase. Both species have the darkened areas of the wings uniformly colored, not pale with darkened margins as in many members of the genus.

245. **LIMNOPHILA (PRIONOLABIS) ATROFEMORATA** Alexander.

Limnophila (*Prionolabis*) *nigrofemorata* ALEXANDER, Philip. Jour. Sci. 66 (1938) 117–118, *pl. 1, fig. 14* (venation), *pl. 3, fig. 39* (♂ hypopygium); preoccupied by *Limnophila nigrofemorata* ALEXANDER, U. S. Nat. Mus. Proc. 72 art. 2 (1927) 14.

Limnophila (*Prionolabis*) *atrofemorata* ALEXANDER, Shikoku Ent. Soc. Trans. 4 (1954) in press.

The types were from Mount Nansho, Rikuchiu (Iwate), Honshu, altitude 2,600 feet, taken November 4, 1934, by Kato.

IYO: Omogo Valley, altitude 800 meters, November 9, 1953 (*Mohri, Tachikawa*); Mount Ishizuchi, altitude 1,600 to 1,800

meters, October 18, 1952 (*Mohri*); Mominoki, altitude 700 to 800 meters, November 15, 1953 (*Yano*); Mount Saragamine, altitude 800 to 900 meters, November 15, 1953 (*Yano*).

The males are fully winged but the female, discovered by Yano, has the wings very reduced. The males are generally similar to the types, differing in minor regards. Antennæ definitely 16-segmented. Male hypopygium with the spinulose points at outer end of lobe of the inner dististyle more reduced, both in size and number. One specimen, on both wings, has cell M_2 open by the atrophy of the basal section of vein M_3.

Male.—Length, about 10 to 12 millimeters; wing, 11 to 14.

Female.—Length, about 7 millimeters; wing, 1.0 × 0.15.

Quite different in its general appearance from the male, due to the very reduced wings and resultant flightless condition. Legs much paler, brownish testaceous, relatively short; segments with abundant long erect setæ that are much longer than the segment at the point of their insertion. Wings reduced to small long-oval scales, obscure yellow; venation reduced and entirely distorted.

Allotype, female, Mount Saragamine, Iyo, altitude 800 to 900 meters, November 15, 1953 (*Yano*).

Although the females in the subgenus *Prionolabis* are commonly fully winged, various species occur in both the Nearctic and eastern Palaearctic faunas where the wings are reduced. The present fly represents the extreme condition known to me.

246. LIMNOPHILA (PRIONOLABIS) IYŒNSIS sp. nov. **Plate 3, figs. 29, 30.**

Size medium (wing, male, 5.5 to 6 millimeters); general coloration black; halteres yellow; legs black, the femoral bases restrictedly paler; wings with a strong blackish tinge, the prearcular field restrictedly pale yellow; cell M_1 lacking; male hypopygium with the posterior border of the ninth tergite virtually truncate; outer dististyle broad, its inner margin with a single broad tooth; inner dististyle extended into a slender nearly straight rod; gonapophysis terminating in a long curved spine, with a second shorter recurved spine at near midlength; ædeagus relatively narrow, the apical filament proportionately short.

Male.—Length, about 4.6 to 5.2 millimeters; wing, 5.5 to 6.1; antenna, about 1.1 to 1.3.

Female.—Length, about 6 to 6.5 millimeters; wing, 6.5 to 7.

Rostrum and palpi black. Antennæ 16-segmented, black; flagellar segments oval, about as long as their verticils. Head opaque black, sparsely pruinose.

Thorax black, the surface of the notum subnitidous, the pleura more pruinose, especially ventrally. Halteres pale yellow. Legs with the coxæ pruinose; trochanters brownish black; remainder of legs black, the femoral bases restrictedly obscure yellow. Wings (Plate 3, fig. 29) with a strong blackish tinge, the prearcular field restrictedly pale yellow; stigma slightly darker than the ground; veins brown, yellow in the prearcular area. Venation: Sc_1 ending shortly beyond fork of Rs, Sc_2 slightly removed from the tip; Rs weakly angulated at origin; cell M_1 lacking; m-cu at near midlength of M_{3+4}.

Abdomen black. Male hypopygium (Plate 3, fig. 30) with the posterior border of the tergite, *9t*, thickened, virtually truncate to vaguely emarginate. Outer dististyle, *d*, broad, extended into a long outer spine, with a broader tooth on inner margin beyond midlength. Inner dististyle extended into a slender nearly straight rod, the narrow simple tip obliquely truncated to subacute. Gonapophysis, *g*, as shown, terminating in a long curved spine, with a second shorter recurved spine at near midlength. Ædeagus, *a*, relatively narrow, the apical filament proportionately short.

Habitat.—Japan (Shikoku).

Holotype, male, Kurotaki, Iyo, altitude 600 meters, May 9, 1953 (*Kusunoki*). Allotopotype, female. Paratopotypes, 3 males and females; paratype, male, Sugitate, Iyo, April 14, 1953 (*Mohri*).

The most similar species is *Limnophila* (*Prionolabis*) *kunumiana* Alexander, of Kyushu, which differs in the structure of the hypopygium, particularly the tergite, other dististyle, and gonapophysis.

247. LIMNOPHILA (PHYLIDOREA) MUNDELLA Alexander.

Limnophila mundella ALEXANDER, Philip. Jour. Sci. 44 (1931) 357.

Hitherto known only from the alpine regions of Honshu. The fly is most nearly allied to *Limnophila* (*Phylidorea*) *subcostata* Alexander, and its race *L.* (*P.*) *subcostata claggi* Alexander, of the Nearctic Region, being best distinguished by the structure of the male hypopygium, particularly the spinous gonapophyses.

IYO: Omogo Valley, altitude 800 meters, June 2, 1953 (*Mohri*).

248. LIMNOPHILA (DICRANOPHRAGMA) PERLATA sp. nov. **Plate 3, fig. 32.**

Mesonotal præscutum with the restricted ground dark brown, the disk with three very extensive brownish yellow stripes; antennal pedicel and basal segment of flagellum orange, the

succeeding segments black; wings (male) very broad, widest opposite the termination of vein 2nd A; a conspicuous brown pattern that is virtually restricted to the vicinity of the veins, without dots or freckling in the cells; cell 1st M_2 unusually small, subquadrate.

Male.—Length, about 7 millimeters; wing, 6.5.

Rostrum and palpi black. Antennæ with scape darkened, pedicel and first flagellar segment orange, succeeding segments passing into black; flagellar segments becoming elongate, with very long verticils. Head dark brown.

Pronotum concealed in the unique type. Mesonotal præscutum with the restricted ground dark brown, the remainder of disk occupied by three brownish yellow stripes, the interspaces very limited; scutum brownish yellow, posterior sclerites of notum darker, the posterior two-thirds of the mediotergite even more blackened. Pleura obscure yellow, variegated with blackened areas on the ventral half. Halteres pale yellow. Legs with the coxæ brownish black; trochanters dark brown; remainder of legs broken. Wings (Plate 3, fig. 32) with the ground pale yellow, the prearcular field more intensely so; a conspicuous brown pattern, arranged about as in *formosa*, including about seven costal darkenings of which four and five at the stigma are confluent; six and seven are likewise confluent, continued caudad over the supernumerary crossvein; conspicuous seams over the cord and outer end of cell 1st M_2; marginal darkenings at ends of veins R_4 to 2nd A, inclusive; a cloud at fork of M_{1+2}; four or five marginal clouds in cell 2nd A; centers of cells M and Cu extensively washed with paler brown; a similar linear brown line in cell 1st A; no spots or dots in the wing cells, as in various other members of the subgenus; veins yellow in the interspaces, darker in the patterned areas. Wings of male very broad, representing the extreme condition in the present faunal area, widest opposite the termination of vein 2nd A. Venation: Cell 1st M_2 unusually small, subquadrate.

Abdomen dark brown, the sternites vaguely more bicolored, the posterior borders of the segments somewhat paler; hypopygium dark. Male hypopygium generally as in *formosa* and other members of the subgenus; tergite produced medially but apparently without lateral lobes.

Habitat.—Japan (Shikoku).

Holotype, male, Mount Saragamine, Iyo, altitude 1,200 meters, July 25, 1953 (*Kusunoki*).

The present fly is most similar to *Limnophila* (*Dicranophragma*) *formosa* Alexander, which differs especially in the narrower wings of the male, with a different venation. A male from Kyoto (June 24, 1923, taken by Takeuchi) may represent this same species but is not well preserved.

249. NIPPOLIMNOPHILA OMOGIANA sp. nov. **Plate 3, fig. 31; plate 4, fig. 38.**

General coloration dark brown; antennæ (male) elongate, nearly one-half the wing, 13-segmented, dark brown throughout; halteres very long, approximately equal in length to the entire thorax; legs brown; wings weakly suffused with brown, the prearcular field more yellowed; male hypopygium with the tergite produced medially into a slender lobe; outer dististyle a simple gently curved blade that narrows into a strong black spine; inner dististyle smaller, appearing as a blackened spine, its tip narrowly obtuse; gonapophysis flattened, narrowed into a long apical spine; ædeagus unusually long and slender, decurved beyond midlength.

Male.—Length, about 4.5 millimeters; wing, 5; antenna, about 2.3 to 2.4.

Rostrum and palpi black. Antennæ (male) elongate, nearly one-half the length of wing, 13-segmented, dark brown throughout; pedicel elongate, as in the genotype, only a trifle shorter than the scape; flagellar segments elongate-cylindrical, much longer than the sparse verticils and the shorter abundant erect pubescence; terminal segment elongate, about one-fourth longer than the penultimate. Head dark brown; anterior vertex broad.

Thorax almost uniformly dark brown; the pleura somewhat darker dorsally. Halteres very long, approximately equal to the entire thorax, weakly infuscated. Legs with the coxæ light brown; trochanters yellow; remainder of legs brown, the outer tarsal segments still darker. Wings (Plate 3, fig. 31) weakly suffused with brown, the stigmal area a trifle darker, prearcular field more yellowed; veins very pale brown, brighter in the prearcular field. Venation Sc short, Sc_1 punctiform, Sc_2 longer, ending distinctly before the fork of Rs; cell M_1 lacking; m-cu at near midlength of M_{3+4}; cell 2nd A long and narrow.

Abdomen dark brown. Male hypopygium (Plate 4, fig. 38) with the tergite, *9t*, produced medially into a slender lobe, provided with microscopic setæ; dorsal surface of tergite with a single row of few long setæ; ninth sternite more broadly and obtusely produced. Outer dististyle, *d*, a simple gently curved blade that narrows into a strong black spine; outer surface with

a few strong setæ. Inner dististyle smaller, appearing as a simple slender curved spine, the tip narrowly obtuse. Gonapophysis, *g*, flattened, narrowed into a long apical spine. Ædeagus *a*, unusually long and relatively slender, decurved beyond mid-length.

Habitat.—Japan (Shikoku).

Holotype, male, Omogo Valley, Iyo, altitude 700 meters, April 26, 1953 (*Yano*). Paratopotype, male.

This fly is readily told from the only other species having elongate antennæ, *Nippolimnophila yakushimana* Alexander, by the very long 13-segmented antennæ and by the structure of the male hypopygium, especially the tergite, dististyles, gonapophyses and ædeagus.

250. HEXATOMA (ERIOCERA) NIGROTROCHANTERATA (Alexander).

Eriocera nigrotrochanterata ALEXANDER, Philip. Jour. Sci. 49 (1932) 123, *pl. 1, fig. 14* (venation).

The type, a male, was from Mount Ohdai, Yamato, Honshu, taken June 5, 1930, by Sakaguchi. I am characterizing the present female specimen as allotype.

Female.—Length, about 24 millimeters; wing, 15.5 × 5; antenna, about 4.5.

Antennæ 9-segmented, relatively short; flagellar segments gradually decreasing in length and diameter outwardly, provided with long setæ. Darkened apex of posterior femur narrow, including about the outer fifth; all trochanters black. Genital shield brownish black. Ovipositor with the cerci powerfully constructed, compressed-flattened, lying subvertically, somewhat as in *Tipula* (*Vestiplex*) species.

Allotype, female, Komi, Iyo, Shikoku, August 4, 1952 (*Kusunoki*).

251. HEXATOMA (ERIOCERA) NIPPONENSIS (Alexander).

Eriocera nipponensis ALEXANDER, Ent. Soc. America Ann. 11 (1918) 446–447.

Eriocera nipponensis ALEXANDER, Ent. Mag. (Kyoto) 3 (1919) 126–127.

The types were from Kyoto, Honshu, collected May 28, 1914 by Nohira.

SANUKI: Ikenobe, Hirai-chô, July 17, 1953 (Chûjô).

252. ATARBA (ATARBODES) MINUTICORNIS Alexander. **Plate 3, fig. 33.**

Atarba (*Atarbodes*) *minuticornis* ALEXANDER, Philip. Jour. Sci. 42 (1930) 526.

The type was from Kosugidani, Yakushima, altitude 2,500 feet, taken April 29, 1929 by Issiki.

Iyo: Omogo Valley, June 6, September 28, 1952 (*Yano*).

In the type the thorax is dull testaceous yellow, with vague indications of darker color in the region of the lateral præscutal stripes. The legs of the type were broken. The present material agrees closely with the type except for the increase in amount of dark color on the notum, especially the posterior parts; scutal lobes ringed with black; scutellum chiefly blackened. The tips of the femora are narrowly and abruptly black. Wings (Plate 3, fig. 33) with the veins pale and poorly differentiated against the ground.

253. ELEPHANTOMYIA (ELEPHANTOMYIA) HOKKAIDENSIS Alexander.

Elephantomyia (*Elephantomyia*) *hokkaidensis* Alexander, Philip. Jour. Sci. 24 (1924) 580–581.

Elephantomyia (*Elephantomyia*) *hokkaidensis* Ito, Mushi 18, pt. 14 (1948) 89–90.

Elephantomyia hokkaidensis Esaki, et al., Icon. Insect. Japon. Ed. 2 (1950) 1525, *fig.*

The types were from various stations in Hokkaido, taken in August and September, 1922 by Esaki. Later found in Honshu.

Iyo: Mount Ishizuchi, altitude 1,600 to 1,800 meters, October 18, 1952 (*Mohri*); Mominoki, Mount Saragamine, altitude 700 to 800 meters, November 15, 1953 (*Yano*).

The species is readily told from other members of the subgenus so far found in Shikoku by its large size and by the simple gonapophyses of the male hypopygium. *Elephantomyia* (*Elephantomyia*) *takachihoi* Ito (1948) from Kyushu seems to be closely related but appears to be distinct by the coloration, as the darkened male hypopygium.

ERIOPTERINI

CLADURA Osten Sacken

This genus, unusually rich in species in Japan, now has seven species known from Shikoku. In this faunal area, the species fall in two distinct groups, based on the structure of the male hypopygium. One of these the *megacauda* group, known at the present time by eight species occurring in Hokkaido and Honshu, but with no known representatives in the two southern islands, is separated by the structure of the basistyle of the hypopygium, which is produced into a long apical lobe that strongly resembles the dististyle in general shape and size. The other forms have the basistyle unproduced, with the dististyle terminal in

position. All known members of the genus are autumnal, flying in September to November.

(50). CLADURA (CLADURA) DECEM-NOTATA Alexander.

Additional records–Iyo: Sugitate, near Matsuyama, November 3, 1953 (*Mohri*); Mominoki, altitude 700 to 800 meters, November 15, 1953 (*Yano*); Mount Saragamine, altitude 600 meters, October 20, 1953 (*Mohri*); Mount Takanawa, altitude 300 to 800 meters, October 25, 1953 (*Ide-Kusunoki*).

254. CLADURA (CLADURA) HAKONENSIS PORRECTA subsp. nov. Plate 4, fig. 39.

Close to typical *hakonensis* Alexander, of Honshu, differing especially in slight details of structure of the male hypopygium, as the gonapophyses.

Male.—Length, about 7 to 7.5 millimeters; wing, 7.5 to 8.5.

Female.—Length, about 7.5 to 8 millimeters; wing, 9 to 10.

Rostrum and palpi dark brown. Antennal scape light brown, pedicel obscure yellow, flagellum varying from pale to darker brown; flagellar segments elongate, with moderately conspicuous verticils. Head gray.

Pronotum infuscated, paler medially. Mesonotal præscutum brown, the humeral region yellow; scutal lobes darkened, the central area obscure yellow; scutellum and mediotergite grayish brown, yellowed laterally. Pleura and pleurotergite yellow, the mesepisternum and mesosternum slightly more infuscated. Halteres with stem whitened, the knobs obscure yellow to weakly infuscated. Legs with the coxæ and trochanters testaceous yellow; femora obscure yellow to brownish yellow, the tips narrowly dark brown, the amount subequal on all legs; tibiæ obscure yellow, with still narrower darkened tips; tarsi black, wings faintly yellowed, more conspicuously so at base; stigmal region yellowed; veins dark brown, conspicuous, the basal ones yellowed. Venation: R_2 generally atrophied or virtually so, when evident lying nearly opposite to just beyond the tip Sc_1; in the paratype male the vein is clearly preserved; petiole of cell M_1 approximately twice m or slightly less; m-cu usually at or close to fork of M, more rarely more distad, in cases up to three-fourths its own length.

Abdomen dark brown, ninth segment of male more blackened to form a narrow ring; hypopygium yellowish brown. Male hypopygium (Plate 4, fig. 39) with the tergite, *9t*, produced medially into a membranous sheet that is densely covered with microscopic setulæ arranged in more or less distinct transverse lines or narrow bands. Basistyle, *b*, elongate, simple. Dististyle, *d*,

small, less than one-half as long as the basistyle, gently curved and narrowed to the obtuse tip. Central plate of phallosome produced into a sharp median point. Gonapophysis slender, bearing an acute appressed spine at near two-thirds the length. Ædeagus, *a*, small, a very little longer than the apophysis.

Habitat.—Japan (Shikoku).

Holotype, male, Omogo Valley, Iyo, November 12, 1953 (*Mohri*). Allotopotype, female. Paratopotypes, 2 females, 1 male, with the type (*Miyatake*); paratypes, 2 females, Mominoki, Mount Saragamine, altitude 700 to 800 meters, November 15, 1953 (*Yano*), 1 female, Mount Takanawa, altitude 900 meters, October 25, 1953 (*Kusunoki*).

Very close to the typical form but apparently distinct in the characters indicated above.

255. **CLAUDURA (CLAUDURA) MACHIDELLA** Alexander. **Plate 4, fig. 40.**

Cladura (*Cladura*) *machidella* ALEXANDER, Philip. Jour. Sci. 55 (1934) 50–51, *pl. 1, fig. 19* (venation).

The unique type female was taken on Mount Hiei, Kyoto, Honshu, October 30, 1933, by Jiro Machida. No other material was known to me until the species was re-discovered in Shikoku.

IYO: Omogo Valley, November 12, 1953 (*Mohri*).

Male.—Length, about 7.5 millimeters; wing, 9.

Characters generally as in the female. Venational details slightly different: Sc_1 much shorter, less than three times Sc_2; supernumerary crossvein in cell R_3 lying more basad, about its own length before the one in cell R_3.

Male hypopygium (Plate 4, fig. 40) with the tergite, *9t*, large, narrowed posteriorly, the border conspicuously biemarginate, there being a narrow median notch at the base of the broad outer one; lobes narrow, the tips obtusely rounded, without major setæ. Basistyle, *b*, elongate, dilated on mesal face of basal half; a small apical tubercle on mesal face. Dististyle, *d*, flattened, terminating in a short curved point; inner or mesal half of style with unusually long pale setæ. Gonapophysis, *g*, appearing as a flattened blackened plate, its apex farther produced into a slender outer rod, the margin of the expanded blade conspicuously serrate. Ædeagus, *a*, relatively long, slender, exceeding the apophyses in length, bent back upon itself near origin and curved at nearly a right angle on outer fourth.

Allotype, male, Omogo Valley, Iyo, November 12, 1953 (*Mohri*).

As was indicated earlier, it is possible that the number and arrangement of the crossveins of the wing may prove to be variable. This has been found to be the case in the genotype, *Cladura* (*Cladura*) *flavoferruginea* Osten Sacken, of the eastern Nearctic Region.[3]

256. CLAUDURA (CLAUDURA) MICROPHALLUS sp. nov. **Plate 4, figs. 34, 41.**

Size large (wing, male, 9 millimeters or more); mesonotum buffy brown, the præscutum with a more blackened central stripe; pleura buffy yellow; femora yellow, the tips narrowly blackened, the amount subequal on all legs; wings weakly tinged with yellow, restrictedly patterned with brown; a supernumerary crossvein in cell R_3 and usually one in cell R_5; male hypopygium with the tergal lobes broad; basistyle unusually long and slender; gonapophysis blackened more or less bilobed, the margin crenulate; ædeagus unusually small, shorter than the apophyses.

Male.—Length, about 7 to 8 millimeters; wing, 9 to 9.5.

Rostrum and palpi dark brown. Antennæ brownish yellow, the bases of the flagellar segments a trifle more darkened; outer segments more uniformly darkened, flagellar segments broadest near base, narrowed outwardly, with long verticils. Head gray.

Pronotum buffy brown. Mesonotum chiefly buffy brown, the præscutum with three darker stripes, the median one darkest, especially on the cephalic part which is brownish black. Pleura buffy yellow. Halteres with stem whitened, knob weakly infuscated. Legs with coxæ and trochanters yellow; femora and tibiæ yellow, the tips narrowly blackened, the amount subequal on all legs; tarsi passing into black. Wings (Plate 4, fig. 34) weakly tinged with yellow, clearer yellow at base; a restricted but conspicuous brown pattern, including the cord, outer end of cell 1st M_2, origin of Rs, Sc_2, R_2, the supernumeraries, and as more or less distinct seams on veins Cu and 2nd A; veins brown, darker in the clouded areas, more yellowed at wing base. Venation: A supernumerary crossvein in cell R_3 and usually with one in cell C_5; Sc_2 beyond fork of R_{2+3+4}; petiole of cell M_1 short, at most twice m; m-cu beyond fork of M, in cases to fully its own length.

Abdominal tergites dark brown, the sternites more yellowish brown, with narrow brown posterior borders; hypopygium

[3] Alexander, Charles P., and M. D. Leonard. Venational variation in *Cladura* (Tipulidæ, Diptera). N.Y. Ent. Soc. Jour. **20** (1912) 35–39, *pl 4*.

chestnut brown. Male hypopygium (Plate 4, fig. 41) with the tergite, *9t*, large, narrowed outwardly, the posterior border biemarginate, the smaller median notch provided with thickened folds, the larger outer emargination relatively narrow, the lobes correspondingly broad. Basistyle, *b*, unusually long and slender, the mesal face more expanded on less than the basal half; outer tubercle undeveloped. Dististyle, *d*, small, only about one-third as long as the basistyle, narrowed outwardly, the upper surface with a blackened line (this perhaps an artifact caused by compression in the slide mount); surface with dense setulæ, the lower half with very long scattered setæ. Gonapophysis, *g*, blackened, more or less bilobed, the lower lobe roughened or crenulate but scarcely toothed. Ædeagus, *a*, unusually small, stout at base, shorter than the apophyses.

Habitat.—Japan (Shikoku).

Holotype, male, Omogo Valley, Iyo, November 12, 1953 (*Mohri*). Paratopotype, 1 male, November 12, 1953 (*Miyatake*). Paratypes, 1 male, Mominoki, Mount Saragamine, altitude 700 to 800 meters, November 15, 1953 (*Yano*); 1 male, Mount Takanawa, altitude 950 meters, October 24, 1953 (*Kusunoki*).

The present fly is most nearly related to *Cladura* (*Cladura*) *machidella* Alexander, agreeing chiefly in the patterned wings with supernumerary crossveins in certain of the outer radial cells, differing conspicuously in the coloration of the body and legs and in the structure of the male hypopygium, especially the styli, gonapophyses and unusually small ædeagus. *C.* (*C.*) *fuscivena* Alexander, of Honshu, of which the male sex is still unknown, is smaller, with the coloration of the body and wings slightly different.

(51). CLADURA (CLADURA) SERRIMARGO Alexander.

Additional records—Iyo: Omogo Valley, November 9, 1953 (*Kusunoki*), November 12, 1953 (*Mohri*); Mount Saragamine, altitude 800 to 900 meters, November 15, 1953 (*Yano*); Mount Takanawa, altitude 800 meters, October 23 to 25, 1953 (*Kusunoki*).

257. CLADURA (CLADURA) SHOMIO sp. nov. **Plate 4, figs. 35, 42.**

General coloration of thorax dark plumbeous gray; antennæ brownish black; femora obscure yellow, the tips darkened, more narrowly and abruptly so on the posterior pair; wings weakly infuscated, vaguely patterned with darker; Sc relatively

short, Sc_1 ending opposite R_2; cell 1st M_2; very small, only about one-half the petiole of cell M_1; male hypopygium with the tergite membranous at apex; basistyle long and slender, without mesal lobes; gonapophysis appearing as a curved hook, with a small lateral spine on basal half; ædeagus short and stout, subequal in length to the apophyses.

Male.—Length, about 6 millimeters; wing, 7.

Rostrum and palpi brownish black. Antennæ brownish black throughout; flagellar segments passing into subcylindrical, with conspicuous verticils and a shorter white pubescence. Head dark gray; anterior vertex broad.

Thorax almost uniformly dark plumbeous gray; pronotal scutellum obscure brownish yellow; præscutum with a broad still darker central stripe, the lateral pair narrow and inconspicuous. Halteres with stem white, knob weakly infuscated. Legs with the coxæ and trochanters testaceous yellow, the fore coxæ narrowly more darkened basally; femora obscure yellow, the tips darker, more abrupt but very narrowly so on the posterior legs; tibiæ brownish yellow, the tarsi passing into brownish black. Wings (Plate 4, fig. 35) weakly infuscated, the prearcular field yellowed; a vague to scarcely indicated darker clouding, best-indicated over the cord and outer end of cell 1st M_2; veins brown, conspicuous, including R_2, those at wing base yellow. Venation: Sc relatively short, Sc_1 ending opposite R_2, Sc_2 nearly opposite fork of R_{2+3+4}; Rs subangulate at origin, its basal part long so cell R_1 is unusually wide; cell 1st M_2 very small, only about one-half the petiole of cell M_1; m-cu just beyond the fork of M; vein 2nd A short and nearly straight.

Abdomen dark brown, including the hypopygium, the ninth segment more blackened to produce a narrow subterminal ring. Male hypopygium (Plate 4, fig. 42) with the tergite, *9t*, broad, its posterior portion produced shortly into small lateral points, the median area membranous and its limits difficult to determine. Basistyle, *b*, long and slender, without lobes on mesal face. Dististyle, *d*, small, slender, narrowed to the short curved point, the length less than half that of the basistyle; a sligthly indicated outer glabrous flange or narrowing. Gonapophysis, *g*, appearing as a curved spine, with a small appressed lateral spine on outer margin of basal half. Ædeagus about as long as the apophyses, stout at base.

Habitat.—Japan (Shikoku).

Holotype, male, Mount Saragamine, Iyo, altitude 800 to 900 meters, November 15, 1953 (*Yano*).

In its dark coloration and virtually unpatterned wings, this fly is most like *Cladura* (*Cladura*) *hakonensis* Alexander, differing in the venation and in the details of structure of the male hypopygium.

258. CLADURA (CLADURA) TETRASPILA Alexander. **Plate 4, fig. 43.**

Cladura tetraspila ALEXANDER, Ent. Soc. America Ann. 40 (1947) 361–362.

The types were from Gora, Hakone District, Honshu, taken in November, 1931 by Sawada.

IYO: Mount Ishizuchi, altitude 1,600 to 1,800 meters October 18, 1952 (*Mohri*); Omogo Valley, altitude 800 meters, November 9, 1953 (*Kusunoki*), November 13 and 14, 1953 (*Mohri*); Mominoki, altitude 700 to 800 meters, November 15, 1953 (*Yano*); Mount Saragamine, altitude 800 to 900 meters, November 15, 1953 (*Yano*); Mount Takanawa, altitude 950 meters, October 23, 1953 (*Kusunoki*).

Male hypopygium (Plate 4, fig. 43) with the posterior border of tergite, *9t*, produced into a subquadrate plate, its margin irregularly emarginate, the central part darkened, its margin appearing erose, the lateral angles obtuse and paler. Basistyle, *b*, long and slender, without lobes or other armature. Dististyle, *d*, single, terminal in position, profoundly bifid into two subequal arms, the outer one more nearly glabrous, especially on its basal part; inner arm subacute at tip, the surface with abundant setæ, those of the outer third smaller. Phallosome, *p*, small and simple, including the short slender ædeagus and broadly flattened gonapophyses that form a partial collar around the base, the apex microscopically spinulose.

259. GONOMYIA (GONOMYIA) OMOGOENSIS sp. nov. **Plate 4, figs. 36, 44.**

Mesonotal præscutum and scutal lobes extensively grayish brown, the posterior sclerites of notum and the pleura yellow; rostrum light yellow; knob of halteres yellowed; legs dark brown, the femoral bases restrictedly obscure yellow; wings brownish gray; Sc relatively long, Sc_1 ending beyond one-third the length of Rs; R_{2+3+4}; a little longer than R_3, cell R_3 large; male hypopygium with the inner dististyle complex, including a flattened dark-colored blade that terminates in a slender apical spine, with two further marginal spines nearer base; phallosome long and slender, pale, bearing laterally a single blackened spine.

Male.—Length, about 4.5 millimeters; wing, 5.

Female.—Length, about 5.2 millimeters; wing, 5.5.

Rostrum light yellow; palpi black. Antennæ black, the proximal half of scape yellowed; flagellar segments long-oval, becoming linear outwardly, with conspicuous verticils. Head gray.

Pronotum yellow. Mesonotal præscutum chiefly grayish brown, the color produced by three virtually confluent stripes, the humeral and lateral parts obscure yellow; pseudosutural foveæ reddened; scutum yellow medially, the lobes grayish brown; scutellum and postnotum yellow. Pleura and pleurotergite reddish yellow, with a broad paler yellow longitudinal stripe between; dorsopleural membrane brighter yellow. Halteres with stem pale, knob yellowed. Legs with the coxæ and trochanters pale yellow; remainder of legs dark brown, the femoral bases restrictedly obscure yellow. Wings (Plate 4, fig. 36) brownish gray, the prearcular and costal fields more yellowed; stigma not or scarcely differentiated; veins brown, paler in the flavous portions. Venation: Sc relatively long, Sc_1 ending beyond one-third the length of Rs; cell R_3 large, vein R_3 only a little shorter than the gently arcuated R_{2+3+4}; basal section of R_5 short, r-m correspondingly long, transverse; cell 1st M_2 closed, gently widened outwardly, shorter than vein M_4; m-cu beyond fork of M, in cases up to about one-third its length.

Abdominal tergites brown, yellowed laterally, sternites clearer yellow. Ovipositor with the valves elongate, the cerci very slender, only gently upcurved. Male hypopygium (Plate 4, fig. 44) with the apical lobe of basistyle, *b*, a little more than one-half as long as the more slender outer dististyle, the latter narrowed to the apex. Inner dististyle, *d*, complex, consisting of a flattened dark-colored blade that is extended into a slender apical spine, with two further marginal spines near base, the outer one longer and more slender; on face of blade with the usual strong rostral portion, narrowed outwardly and terminating in two unequal powerful bristles, the lower one stouter. Phallosome, *p*. a long slender pale structure that juts beyond the level of the dististyles, on its lateral portion near base bearing a single blackened rod or spine, this gently curved, narrowed to the acute tip.

Habitat.—Japan (Shikoku).

Holotype, male, Omogo Valley, Iyo, altitude 800 meters, June 6, 1952 (*Yano.*) Allotopotype, female, pinned with type.

Readily distinguished from all regional species, as *Gonomyia* (*Gonomyia*) *gilvipennis* Alexander, by the structure of the male hypopygium, particularly the diagnostic inner dististyle.

260. ERIOPTERA (EMPEDA) JAPONICA Alexander. **Plate 4, fig. 37.**

Erioptera (*Empeda*) *japonica* ALEXANDER, Insec. Inscit. Menst. 8 (1920) 134–135. 3

The type was from near Tokyo, taken December 3, 1919, by Takahashi.

IYO: Mominoki, Mount Saragamine, altitude 700 to 800 meters, November 15, 1953 (*Yano*).

The wing is shown (Plate 4, fig. 37). Attention is called to the unusually long Sc. long Sc_1, oblique R_2, deep cell R_3, narrowing of cell R_5 at wing tip, and the sinuous to slightly upcurved vein M_4. The very long macrotrichia of the veins are noteworthy.

Like *Erioptera* (*Empeda*) *brumalis* Alexander, the present fly appears to be a late autumn or early winter species.

261. MOLOPHILUS (MOLOPHILUS) APICIDENTATUS sp. nov. **Plate 4, fig. 45.**

Belongs to the *gracilis* group and subgroup; size very small (wing under 3.5 millimeters); general coloration brownish black; antennæ short; knobs of halteres slightly infuscated; male hypopygium with the mesal lobe of basistyle profoundly divided into two long acute spines; outer dististyle a blackened rod that forks near apex into two short spines; inner dististyle a long sinuous rod that narrows gradually to the acute tip, the outer third with small but conspicuous denticles.

Male.—Length, about 2.5 to 2.6 millimeters; wing, 3.2 to 3.3; antenna, about 0.7 to 0.75.

Female.—Length, about 3 millimeters; wing, 3.4.

Rostrum and palpi brownish black. Antennæ black throughout, relatively short; verticils long. Head brownish black.

Mesonotal præscutum and scutum brownish black, very sparsely pruinose to appear a dark plumbeous; scutellum in cases paling to obscure brownish yellow, in the type concolorous with the remainder of notum. Pleura brownish black. Halteres pale basally, the long knobs more infuscated. Legs with the coxæ and trochanters testaceous yellow; remainder of legs brownish yellow, the color appearing darker because of the vestiture; outer tarsal segments darkened. Wings grayish, the base more yellowed; veins and macrotrichia darker. Venation: R_2 lying just basad of the level of r-m; petiole of cell M_3 about three times m-cu; vein 2nd A sinuous, elongate, ending nearly opposite fork of M_{3+4}.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 4, fig. 45) with the mesal lobe of basistyle, *mb*,

profoundly divided into two long acute spines; ventral lobe shorter and stouter, fleshy, setiferous. Two dististyles, *d*, the outer a blackened rod that forks near apex into two short spines; inner style long and sinuous, narrowed to the acute tip, its outer third with small but conspicuous denticles. Phallosomic plate broadest at near midlength, the apex obtuse, surface with microscopic setulæ. Ædeagus long and slender.

Habitat.—Japan (Shikoku).

Holotype, male, Omogo Valley, Iyo, altitude 800 meters, June 5, 1952 (*Yano*). Allotopotype, female, pinned with type. Paratopotypes, 2 males.

In the strongly spined apical lobes of the basistyle of the male hypopygium, the present fly suggests species such as *Molophilus* (*Molophilus*) *ferox* Alexander, *M.* (*M.*) *polycanthus* Alexander, and various others, differing from all in the very small size and, especially, in the details of structure of the male hypopygium.

262. MOLOPHILUS (MOLOPHILUS) FEROX Alexander.

Molophilus ferox ALEXANDER, Philip. Jour. Sci. 44 (1931) 365, *pl. 2, fig. 45* (♂ hypopygium).

The type was from the Japanese Alps, taken at Norikuradake, Shinano, July 26, 1929, by Machida.

IYO: Omogo Valley, altitude 800 meters, August 21, 1953 (*Miyatake*).

The type is much paler than the present fly and except for the very similar male hypopygia the two specimens might be held to be distinct. However, there seems to be no necessity of proposing a further name for the present fly but the colorational differences should be noted. General coloration of entire thorax dull black. Halteres with base of stem yellow, the outer half or more infuscated, knob obscure brownish yellow. Legs with the coxæ and trochanters yellow, the remainder brownish black.

In the original description it was stated that what is now considered to represent a dorsal lobe of the basistyle of the male hypopygium was a third dististyle. There are now known several species of the genus in eastern Asia having this dorsal lobe duplicated or complicated in form and it is evident that there are actually only two dististyles, as common in the genus.

263. MOLOPHILUS (MOLOPHILUS) TRIACANTHUS Alexander.

Molophilus triacanthus ALEXANDER, Philip. Jour. Sci. 53 (1934) 294–295, *pl, 1, fig. 21* (venation), *pl. 3, fig. 41* (♂ hypopygium).

The types were from Yumoto, Shimotsuke, Honshu, altitude 4,850 feet, taken June 20, 1932, by Issiki. Now known from various stations in Honshu and also from northern Korea.

IYO: Naose, near Kuma, altitude 600 meters, May 16, 1953 (*Mohri*).

ILLUSTRATIONS

[Legend: *a*, aedeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *i*, interbase; *mb*, mesal lobe of basistyle; *p*, phallosome; *s*, sternite; *t*, tergite; *vb*, ventral lobe of basistyle.]

Plate 1

Fig. 1. *Ctenophora* (*Ctenophora*) *ishiharai* Alexander; venation.
2. *Ctenophora* (*Ctenophora*) *ishiharai* Alexander; antenna, female.
3. *Ctenophora* (*Tanyptera*) *flavoposticata* Alexander; venation.
4. *Ctenophora* (*Tanyptera*) *flavoposticata* Alexander; male hypopygium, dististyles.
5. *Tipula* (*Bellardina*) *ampliata* Alexander; male hypopygium, details.
6. *Tipula* (*Schummelia*) *acifera* Alexander; venation.
7. *Tipula* (*Schummelia*) *acifera* Alexander; male hypopygium, details.
8. *Tipula* (*Schummelia*) *acirostris* Alexander, venation.
9. *Tipula* (*Schummelia*) *acirostris* Alexander; male hypopygium.
10. *Tipula* (*Schummelia*) *omogicola* Alexander; venation.
11. *Tipula* (*Schummelia*) *esakiana* Alexander; venation.

Plate 2

Fig. 12. *Tipula* (*Oreomyza*) *kusunokiana* sp. nov.; venation.
13. *Tipula* (*Oreomyza*) *mohriana* Alexander; venation.
14. *Tipula* (*Oreomyza*) *nigrocostata* Alexander; venation.
15. *Tipula* (*Schummelia*) *omogicola* Alexander; male hyphopygium.
16. *Tipula* (*Schummelia*) *esakiana* Alexander; male hypopygium.
17. *Tipula* (*Oreomyza*) *otiosa* Alexander; male hypopygium.
18. *Tipula* (*Oreomyza*) *otiosa* Alexander; ovipositor, lateral.
19. *Tipula* (*Oreomyza*) *mohriana* Alexander; male hypopygium.
20. *Tipula* (*Oreomyza*) *nigrocostata* Alexander; male hypopygium.

Plate 3

Fig. 21. *Nephrotoma repanda* (Alexander); venation.
22. *Nephrotoma repanda* (Alexander); male hypopygium.
23. *Limonia* (*Limonia*) *ochripes* sp. nov.; venation.
24. *Limonia* (*Limonia*) *ochripes* sp. nov.; male hypopygium.
25. *Dicranoptycha edashigeana* sp. nov.; venation.
26. *Dicranoptycha edashigeana* sp. nov.; male hypopygium.
27. *Epiphragma* (*Epiphragma*) *trichomera* sp. nov.; venation.
28. *Epiphragma* (*Epiphragma*) *trichomera* sp. nov.; male hypopygium.
29. *Limnophila* (*Prionolabis*) *iyoensis* sp. nov.; venation.
30. *Limnophila* (*Prionolabis*) *iyoensis* sp. nov.; male hypopygium.
31. *Nippolimnophila omogiana* sp. nov.; venation.
32. *Limnophila* (*Dicranophragma*) *peralta* sp. nov.; venation.
33. *Atarba* (*Atarbodes*) *minuticornis* Alexander; venation.

PLATE 4

FIG. 34. *Cladura* (*Cladura*) *microphallus* sp. nov.; venation.
35. *Cladura* (*Cladura*) *shomio* sp. nov.; venation.
36. *Gonomyia* (*Gonomyia*) *omogoensis* sp. nov.; venation.
37. *Erioptera* (*Empeda*) *japonica* Alexander; venation.
38. *Nippolimnophila omogiana* sp. nov.; male hypopygium.
39. *Cladura* (*Cladura*) *hakonensis porrecta* subsp. nov.; male hypopygium.
40. *Cladura* (*Cladura*) *machidella* Alexander; male hypopygium.
41. *Cladura* (*Cladura*) *microphallus* sp. nov.; male hypopygium.
42. *Cladura* (*Cladura*) *shomio* sp. nov.; male hypopygium.
43. *Cladura* (*Cladura*) *tetraspila* Alexander; male hypopygium.
44. *Gonomyia* (*Gonomyia*) *omogoensis* sp. nov.; male hypopygium.
45. *Molophilus* (*Molophilus*) *apicidentatus* sp. nov.; male hypopygium.

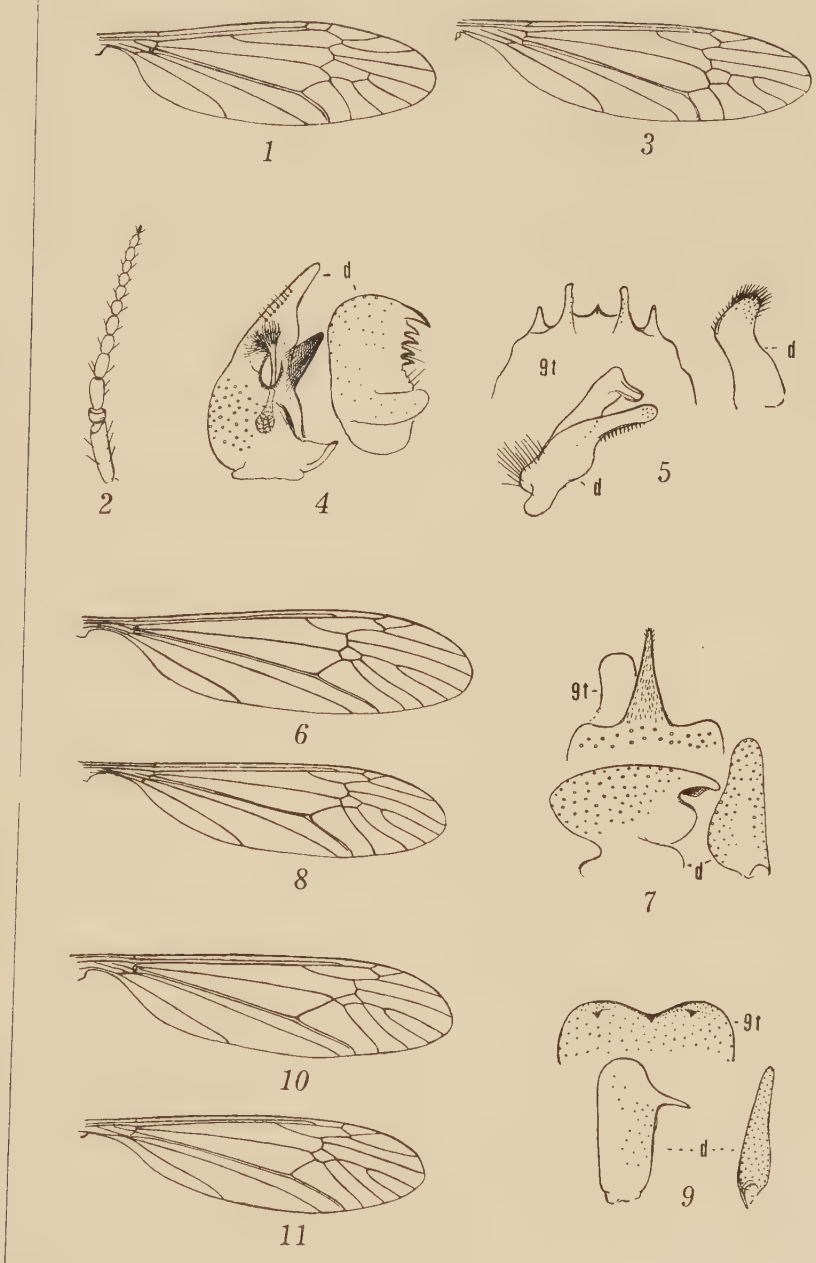
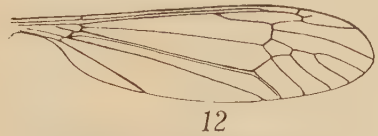


PLATE 1.



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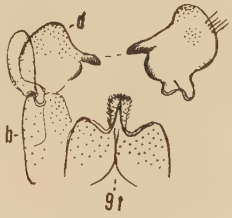

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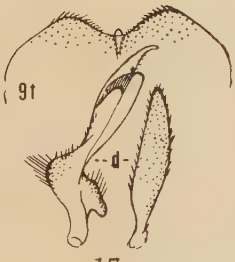

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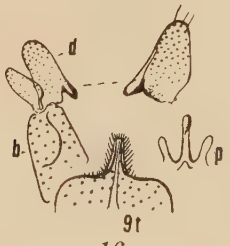

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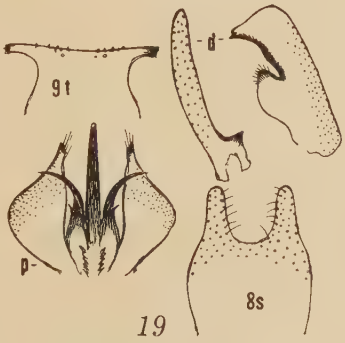

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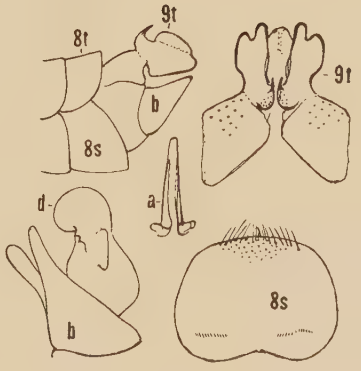

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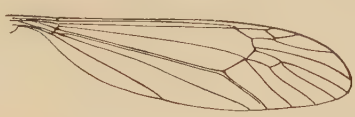

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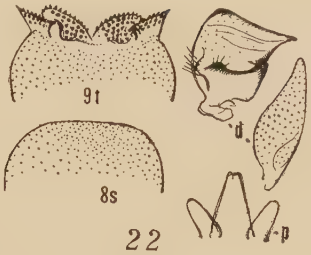

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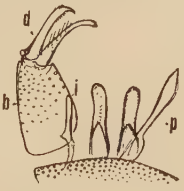

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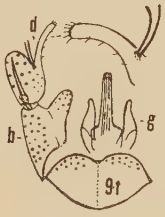

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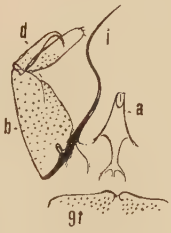

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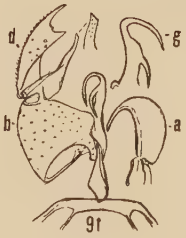

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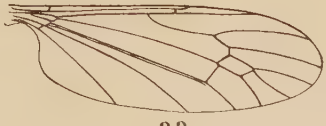

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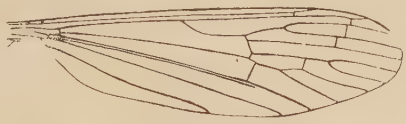

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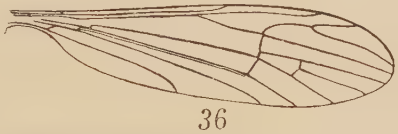

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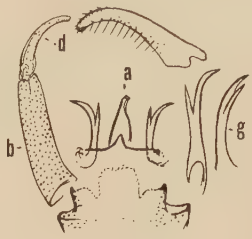

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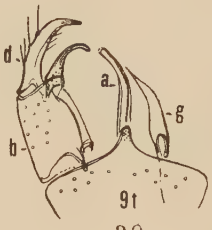

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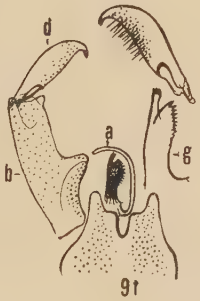

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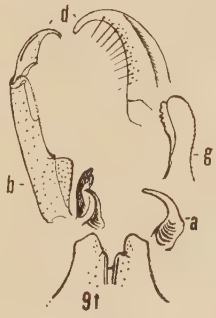

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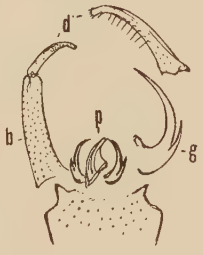

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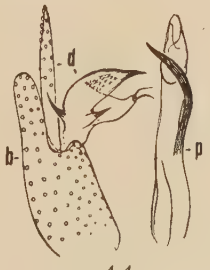

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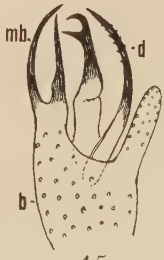

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PLATE 4.

JAPANESE PSYCHODIDÆ, I. PSYCHODA SPECIES

By Masaaki Tokunaga and Etsuko Komyo
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ONE PLATE

Japanese fauna of the Psychodidæ is very little known, only five species of this family having been reported hitherto. These species are *Psychoda alternata* Say reported by Esaki (1932) and Tokunaga [(1951) and (1954)]; *Psychoda fungicola* Tokunaga, by Tokunaga (1953); *Telmatoscopus albipunctatus* Willistone, by Tokunaga (1953); *Psychoda sexpunctata* Curtis, by Okada (1927) and Matsumura (1931); and *Phlebotomus squamirostris* Newstead, by Newstead (1923), Shinoda (1950), and Tokunaga and Komyo (1954).

In this paper the authors who have studied the materials of the Psychodidæ collected from various parts in Japan since 1932, report ten Japanese species of the genus *Psychoda*, of which four species are new to science and four are new to records in Japan. The morphological terminology adopted herein was taken from that of Freeman (1950). The moth-flies were usually clothed thickly with scales which often showed distinct coloration, such as black, yellow or white, and which were very much fragile, especially so when the flies were preserved in alcohol. The authors, without attaching importance to the scale coloration for important specific characters, mainly studied the materials as denuded by immersion in warm caustic potash solution. The main characters considered in classifying the adult moth-flies were the structure of the antennæ, legs, wing venation, male hypopygium, and female subgenital plate.

Abbreviations.—TTR is tibiotarsal ratio, relative length of tibia to that of first tarsal segment of leg. TR is tarsal ratio, relative length of first tarsal segment to that of second tarsal segment of leg. RR is radial ratio, relative length of wing vein R_{2+3} to that of R_2.

Acknowledgments.—The authors wish to express their thanks to Prof. Dr. T. Esaki, and Dr. K. Yasumatsu and Mr. A. Shoji

Contribution from the Entomological Laboratory, Saikyo University, No. 31.

of Kyushu University, and to Dr. G. W. Byers of Washington for the loan of valuable materials and literatures. They are also indebted to Mr. S. Ito of Naniwa University, Osaka; to Mr. Y. Shogaki of Kyoto; to Prof. Dr. T. Ishihara, Mr. M. Miyatake, and Mr. T. Yano of Matsuyama Agricultural College; to Mr. H. Hasegawa and Mr. K. Tanak of Tokyo; to Miss I. Terashima of Uji-yamada; and to Messrs, M. Kubota, T. Kodama, and A. Umeno, who have kindly collected and sent to them the valuable moth-flies for their studies. Mr. S. Sasakawa and Mr. A. Nobuchi of our laboratory also helped a lot during the preparation of this paper.

Key to Japanese Psychoda species.

1. Antennæ 14-segmented ..... *P. severini* Tonnoir
   Antennæ 15-segmented 2
   Antennæ 16-segmented 5
2. Antennal segments 13, 14, and 15 fused together 3
   Antennal segments 13, 14, and 15 all or some separated 4
3. Wings with anterior and posterior fork of veins complete and with dark marginal spots at ends of some veins ..... *P. alternata* Say
   Wings with two forks of veins incomplete and without dark marginal spots ..... *P. setigera* Tonnoir
4. Antennal segments 14 and 15 elongated oval, and 13 fused with 14. Wings without dark spots on veins ..... *P. eriminea* Eaton
   Antennal segments 13, 14, and 15 all separated, 14 and 15 subspherical. Wings without dark spots ..... *P. phalænoides* Linné
5. Wings with anterior and posterior fork of veins incomplete (antennal segments 13, 14, and 15, fused but 16 separated.
   P. malleola Tokunaga et Etsuko, sp. nov.
   Wings with two forks of veins complete 6
6. Antennal segments 13, 14, 15, and 16 separated 7
   Antennal segments 13 to 16 not all separated, some fused with each other 8
7. Antennal segment 16 far smaller than preceding two. Wing vein R_{2+3} short, equal in length to R_2.
   P. itoco Tukonaga et Etsuko, sp. nov.
   Antennal segment 16 subequal in size to preceding two. Wing vein R_{2+3} longer than R_2 ..... *P. longiseta* Tokunaga et Etsuko, sp. nov.
8. Cerci of male hypopygium forficulated, far longer than ninth tergite. Subgenital plate of female with lobes prominent and divergent.
   P. motoharui Tokunaga et Etsuko, sp. nov.
   Cerci of male hypopygium not forficulate, only slightly longer than ninth tergite. Subgenital plate of female with lobes very blunt and obscure ..... *P. fungicola* Tokunaga

PSYCHODA SEVERINI Tonnoir.

This species is highly specific in possession of 14-segmented antennæ, short bilobate subgenital plate of female and two forks

of wing venation. This Japanese fly belongs to the subspecies *parthenogenetica* Tonnoir.

Female.—Body about 1.2 to 1.8 mm long, without distinct colored markings. Antennæ 14-segmented; distal two segments fused; ultimate segment oval and small. Wings about 1.7 to 2.3 mm long; anterior fork far beyond posterior fork; RR 1.5 (1.57, varying 1.52 to 1.61). TTR and TR of hind leg about 2.6 to 2.7 and 2.6 respectively, Subgenital plate slightly shorter than width; two caudal lobes blunt; inner sensory organ short and stout.

Specimens.—Female; Kyoto City; August, 1952 (***Tokunaga***); Matsuyama, Ehime-ken; April, 1952 (*Yano*).

PSYCHODA ALTERNATA Say.

This is a cosmopolitan species and highly characteristic in the structure of the antennæ, mottled pattern of the wing and V-shaped female subgenital plate. Recently the senior author reported this species as a myiasis-producing fly and discussed its synonymy in detail [Tokunaga, M. (1953)].

Male.—TTR of hind leg about 3.6 and wing vein R_{2+3} slightly longer than R_2, RR being about 1.12 (1.1 to 1.2)

Female.—TTR of hind leg about 3.2 (varying 3 to 3.3). RR about 1.23 (1.1 to 1.4).

Specimens.—Males and females: Kyoto City; August and September, 1952 and October, 1953 (*Tokunaga*); Midoro-ike, Kyoto; November, 1953 (*Mr. Y. Shogaki*). Osugidani, Mie-ken; July, 1952 (*Tokunaga*); Matsuyama, Ehime-ken; April and November, 1952 (*Mr. T. Yano*); Sanbongi, Aomori-ken; October, 1935 (*Tokunaga*). Uji-Yamada, Mie-ken, April, 1952 (*Miss I. Terashima*); Onyu, Fukui-ken; July, 1952 (*Tokunaga*); Mt. Ari and Kagi, Formosa; December, 1934 (*Tokunaga*); Amamio-shima, Kagoshima-ken; May, 1932 (*Mr. A. Umeno*); Ishigaki-jima, Okinawa-ken; June, 1932 (*Mr. A. Umeno*); Funabashi, Chiba-ken; August, 1951 (*Mr. K. Tanaka*); Ohiso, Kanagawa-ken; March and May, 1942 (*Mr. H. Hasegawa*).

PSYCHODA SETIGERA Tonnoir.

This species is specific in the following points: Antennæ are similar in structure to those of *P. alternata* Say, but the terminal nodulouse segments are somewhat elongated and the ascoids of flagellar segments are slender and larger. The wings are slender, being fully thrice as long as wide, and both forks

of wing veins are incomplete, the base of caudal branch of each fork being narrowly atrophied.

Female.—Wing vein M_2 about 3.4 times as long as R_3; R_5 ending at wing tip, where is pointed. Subgenital plate more flattened than the original description (1922) with lobes somewhat triangular.

Specimens.—Females; Matsuyama, Ehime-ken; November, 1953 (*Mr. T. Yano*).

PSYCHODA ERIMINEA Eaton.

This species is characteristic in the marking of the wings which are provided with dark spots at wing base, one dark spot at middle of R_1 and R_{2+3}; before tip of R_2, at middle of R_4, on distal part of M_{1+2} and basal part of M_1, at middle of M_1, and before tip of M_3 and Cu_1, respectively. Antennæ are 15-segmented; 13th and 14th segments are fused, but 14th and 15th segments are slightly separated; 14th and 15th segments are somewhat oval and 15th is slightly larger than the preceding one.

Male.—TTR and TR of hind leg about 4.16 and 2.0 respectively. RR about 1.15. Cerci of hypopygium stout, not distinctly swollen basally, not forciculate, each with a slender retinaculum; styles slightly undulate, each with a long seta at basal part.

Specimens.—Males; Midoro-ike, Kyoto; November, 1953; at light (*Mr. Y. Shogaki*).

PSYCHODA PHALÆNOIDES Linné.

This was collected at high altitude, about 1,500 meters, of Japanese Alps. Antennæ are 15-segmented; the distal three segments are very distinctly separated and subspherical. This Japanese moth-fly belongs to Tonnoir's subspecies *elongata.*

Female.—TTR and TR of hind leg about 3.5 and 2.4 RR of wing about 1.27. Subgenital plate with two caudal lobes widely separated from each other by a large hemicircular incision; inner sensory organ large and clavate.

Specimens.—Females; Kamikochi, Nagano-ken; July, 1952, (*Tokunaga*).

PSYCHODA MALLEOLA Tokunaga et Etsuko, sp. nov.

This is a peculiar species provided with basally swollen styles of male hypopygium and incomplete anterior and posterior fork of wing venation.

Male.—Body about 1.1 to 1.2 mm long, without distinct colored marking.

Eyes very narrowly separated above, the distance about half of diameter of a facet. Paraglossæ each with three teeth and sometimes with an additional minute tooth and two small setæ on apical part. Maxillary palpi 4-segmented (15:15:16:22). Antennæ (Fig. 5) 16-segmented, 13th, 14th, and 15th segments fused together; 13th segment spherical, with a pair of Y-shaped ascoids as in the preceding flagellar segments and with many verticils; 14th segment discoidal, with verticils but without ascoids; 15th segment similar to 14th but distinctly smaller; 16th segment small, oval, without ascoids and verticils.

Legs normal; TTR and TR of hind legs 3 to 3.1 and 2.3 respectively. Wings (Fig. 1) about 1.1 to 1.4 mm long; venation: two forks incomplete, the base of each posterior branch atrophied, R_3 arising under or just beyond the end of R_1, M_2 comparatively long, atrophied at its extreme base, about 2.26 times as long as R_3, R_5 ending at tip of wing.

Hypopygium, (Fig. 9) with cerci very long, very slightly arcuated, swollen at extreme base, each with a large spoonlike retinaculum; coxites slightly swollen laterad; styles peculiar in shape, proper part about two-thirds of length of coxite, slightly curved at tip and setigerous with small setæ, basal expansion very large, far larger than proper part and scaly.

Female.—General structure as in male except for sexual difference. Eyes separated above as wide as a facet. Maxillary palpi 4-segmented (13:12.5:14:16.5). Antennæ 16-segmented, relative lengths of distal eight segments about 13.5:13.8:13:11.8:6:2.5:2:3.5. Hind legs with TTR and TR 3.7 to 3.8 and 1.7 to 2 respectively. Wings about 1.2 to 1.4 mm long; vein M_2 about twice as long as R_3. Ovipositor normal; subgenital plate (Fig. 10) bilobated, each lobe hemicircular, widely separated as wide as the lobe itself; inner sensory organ rodlike, about thrice as long as width, with an apical seta.

Locality.—Honsyu, Japan.

Holotype.—Male; Sanbongi, Aomori-ken; October, 1935 (*Tokunaga*).

Allotopotype.—Female; Sanbongi, Aomori-ken; October, 1935 (*Tokunaga*).

Paratypes.—Males and females; Sanbongi, Aomori-ken; October, 1935 (*Tokunaga*); Midoro-ike, Kyoto; November, 1953 (*Mr. Y. Shogaki*).

This species is very closely allied to *P. trinodulosa* Tonnoir. But in allied species, the styles of male hypopygium are normal, not expanding basally and the female subgenital plate is provided

with a gimletlike inner sensory organ. This species is named after its peculiar hammerlike dorsal appendages (coxites and styles).

PSYCHODA ITOCO Tokunaga et Etsuko, sp. nov.

This species is small pale gray moth-fly collected at light in the house.

Male.—Body about 1.6 mm long, with scales broad, and rather scarce. Wings about 2 mm long, milky white and semihyaline. Antennæ 16-segmented; ultimate four segments without neck part, narrowly separated from each other, ultimate one oval, smaller than preceding two. Venation of wing (Fig. 2); fork of R_{1+3} far beyond fork of M_{1+2} but before end of Cu_1, almost equal to R_2 in length. Male hypopygium with slender styles and cerci.

Head oval in frontal aspect. Eyes reniform, narrowly separated above by a distance equal to half the diameter of a facet. Maxillary palpi slender, 4-segmented (18:19:20:27). Paraglossa with two setæ, three large and two small teeth. Antennæ (Fig. 4) 16-segmented; proportional lengths of distal six segments about 24:22:11:4:4:3; distal four segments without elongated neck part and narrowly separated from each other; 13th segment oval, with a pair of Y-shaped ascoids as in the preceding flagellar segments; 14th and 15th segments somewhat flattened, without ascoids, with several verticils, similar in shape to each other; ultimate 16th segment, smaller than preceding two, somewhat oval, with several verticils.

TTR and TR of hind leg about 4.3 and 3 respectively. Wing about 2.6 times as long as width; venation: R_5 ending at wing tip, fork of R_{2+3} beyond that of M_{1+2}, Cu_1 ending beyond fork of R_{2+3}, R_{2+3} arising just beyond base of R_5 and almost always equal to R_2 in length, RR being 1.00.

Hypopygium (Fig. 8) with ninth tergite large; coxite shorter than style, expanded laterad, with many scales on this expansion; style slender, almost straight, only slightly curved at distal end, without scales, with minute setæ; cercus long, arcuate, not distinctly swollen at base, with a spoonlike retinaculum at tip.

Female.—General structure as in male. Eyes narrowly separated above, distance between them about the diameter of a facet. TTR and TR of hind leg about 4 and 2 respectively. Subgenital plate (Fig. 12) as long as width, somewhat M-shaped, with a triangular caudal incision, its internal sensory organ slender, rodlike, with two minute apical setæ.

Locality.—Honsyu, Japan.

Holotype.—Male; Uji-Yamada, Mie-ken; April, 1952 (*Miss Itoko Terashima*).

Allotype.—Female, Kyoto City; August, 1952, (*Tokunaga*).

Paratypes.—Many males and females; Uji-Yamada, Mie-ken; April, 1952 (*Miss I. Terashima*); Kyoto City; August, 1952 and June, 1953 (*Tokunaga*); Midoro-ike, Kyoto; November, 1953 (*Mr. Y. Shogaki*).

This species is somewhat allied to *P. fungicola* Tokunaga and *P. grisescens* Tonnoir, but quite different in the shape of the male hypopygium and the female subgenital plate. We have much pleasure in dedicating this species to Miss Itoko Terashima, who had collected first this species.

PSYCHODA LONGISETA Tokunaga et Etsuko, sp. nov.

This species is often found at light and is very closely allied to an European species, *P. cinerea* Banks, but distinctly differs in the structure of male hypopygium and female subgenital plate.

Male.—Body pale gray or whitish gray, about 1.2 to 1.3 mm long.

Eyes very narrowly separated above, the distance between them shorter than one-third of the diameter of a facet. Paraglossæ slender, each with four teeth and a minute tooth on apical part. Maxillary palpi 4-segmented (15:20:20:21). Antennæ (Fig. 6) 16-segmented; ultimate four segments distinctly separated; 13th segment subspherical, larger than following segments, with a pair of Y-shaped ascoids and many verticils as in preceding flagellar segments; 14th, 15th, and 16th segments diminutive, without ascoids but with many verticils, and subequal; 14th and 15th segments somewhat discoidal but 16th spherical; relative lengths of distal eight segments about 20.3: 20:19.3:17:8:4.8:4.8:4.8.

Ground color of thorax generally pale brown and scutum reddish brown. TTR and TR of hind leg 2.3 to 2.5 and 2.5 to 2.9 respectively. Wing (Fig. 3) with pointed tip where R_5 is ended; venation: R_1 ending just above end of Cu_1, anterior fork beyond posterior fork and before the end of R_1, R_{2+3} far longer than R_2 and RR about 1.4 (1.2 to 1.5).

Hypopygium (Fig. 7): styles shorter than coxites, evenly curved, beaklike, pointed at tip, setigerous with minute setæ, each with a very long seta at middle ventral side; cerci stout, not forficulate, not bulbous at base, evenly swollen basally, each with a large spoonlike retinaculum at tip.

Female.—Body much larger than male, about 2.7 mm long. Eyes narrowly separated above as wide as a facet. Maxillary palpi 4–segmented (20:26:35:40). Antennæ 16–segmented; relative lengths of eight distal segments about 23.5:23:22.5:20:11:5.5:5.5:6.5; distal three segments subequal, subspherical, with verticils less than in male. TTR and TR of hind leg about 2.6 to 2.8 and 2.5 respectively. Wings about 3 mm long; RR about 1.21 (1.12 to 1.22); R_1 ending just before the end of Cu_1. Subgenital plate (Fig. 11) with two caudal lobes which are pointed, triangular, and separated by a triangular caudal incision; inner sensory organ slender, cylindrical, arising from the apex of caudal incision.

Locality.—Honsyu, Japan.

Holotype.—Male; Kyoto City; September, 1952 (*Tokunaga*)

Allotype.—Female; Uji-Yamada, Mie-ken; April, 1952 (*Miss I. Terashima*).

Paratypes.—Males and females; Kyoto City, September, 1952 (*Tokunaga*). Midoro-ike, Kyoto; July, 1952 (*Mr. Y. Shogaki,* at light).

This species is closely allied to *P. cinerea* Banks, which is synonymous with *P. compar* Eaton, but the allied species differs in the following points; styles of the male hypopygium is slender, longer than the coxites and provided with many scales on basal part; and the subgenital plate of the female is provided with blunt hemicircular lobes. The species name is related to the long seta of the style.

PSYCHODA FUNGICOLA Tokunaga.

This is an injurious pest of the Japanese pine mushroom. The senior author previously reported this species in detail [Tokunaga, M. (1953)]. At present the authors intend to correct the previous report as follows: the anterior fork of wing vein beyond the posterior fork and about at middle of wing; RR about 1.75 in male and about 2.0 in female: TTR of hind leg about 3.6 in male and 3.3 in female.

Specimens.—Males and females; Sonobe, Kyoto-fu, October, 1952 (*Mr. A. Nobuchi*).

PSYCHODA MOTOHARUI Tokunaga et Etsuko, sp. nov.

This is common in Kyoto City and often collected in house at light. General feature of this fly resembles that of *P. itoco* Tokunaga et Etsuko but differs in the following points: Antennal segments 14th and 15th are fused as in *P. fungicola* Tokunaga. Wing vein R_{2+3} is far longer than R_2. Female subgenital plate

is provided with two small caudal lobes which are divergent and with a short peglike inner sensory organ.

Male.—Body about 1.9 mm long, generally gray and without distinct colored marking.

Antennæ 16-segmented; 13th segment subspherical, slightly longer than width, with a pair of large Y-shaped ascoids as in preceding flagellar segments; 14th segment separated from 13th and fused with 15th; 14th, and 15th subequal, somewhat discoidal, far smaller than 13th, with many verticils; 16th distinctly separated from 15th, very small oval in shape. Maxillary palpi 4-segmented (21.5:23.5:24.5:32).

TTR of hind leg about 3.7. Wings about 1.8 mm long; venation: anterior fork beyond posterior but before the level of end of Cu_1; RR about 1.17 (1.12 to 1.33); base of R_5 obscure but seems to be just before the origin of R^{2+3}; R_5 ended at tip of wing where is pointed; Cu_1 connected M_{3+4} just before fork of M_{3+4}.

Hypopygium closely similar to that of *P. itoco* Tokunaga et Etsuko; cerci forficulate, far longer than ninth tergite, not distinctly swollen basally, each with a spoonlike retinaculum at tip; styles slender, very slightly curved, pointed.

Female.—Body length about 1.7 mm. Antennæ 16-segmented; 14th and 15th segments always fused together; 13th and 14th separated in normal case, but often fused; 15th and 16th almost always separated but rarely fused. TTR of hind leg about 2.7. Wings darker than in male, about 1.5 mm long; anterior fork beyond posterior but far before tip of Cu_1; RR about 1.23 (1.11 to 1.33). Subgenital plate (Fig. 13) closely similar to that of *P. spreta Tonnoir.*

Holotype.—Male; Kyoto City; June, 1953 (*Tokunaga,* at light).

Allopotype.—Female; Kyoto City; June, 1953 (*Tokunaga,* at light).

Paratypes.—Males and females; Kyoto City; June, 1953 (*Tokunaga*); Midoro-ike; November, 1953 (*Mr. Y. Shogaki,* at light).

This species allied to *P. spreta* Tonnoir, but in the allied species, the distal four segments of the antennæ are all fused together in both sexes, coxites of male hypopygium are not swollen lateral, styles are cylindrical on basal half and entirely covered with long erect setæ, and cerci are somewhat swollen at base. While in the present new species, in the male there are distinct segmacoria between 13th and 14th and 15th and 16th antennal segments, and in female there are very rare that

the distal four segments are fused together, the coxites of male hypopygium are swollen laterad and scaly, styles are entirely slender, taper, very slightly curved at tip and with minute setæ, and cerci are slender and not distinctly swollen at base. It is great pleasure in dedicating this species to the late Mr. Motoharu Tokunaga (1933 to 1941), son of the senior author.

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ILLUSTRATION

[Drawing by Mr. M. Sasakawa]

PLATE 1

(Setæ and scales omitted)

FIG. 1. *Psychoda malleola* sp. nov., wing, male.
2. *P. itoco*, sp. nov., wing, male.
3. *P. longiseta* sp. nov., wing, male.
4. *P. itoco* sp. now., distal segments of antenna, female.
5. *P. malleola* sp. nov., distal segments of antenna, female.
6. *P. longiseta* sp. nov., distal segments of antenna, male.
7. *P. longiseta* sp. nov., genital appendages, male.
8. *P. itoco* sp. nov., genital appendages, male.
9. *P. Malleola* sp. nov., genital appendages, male.
10. *P. malleola* sp. nov., subgenital plate, female.
11. *P. longiseta* sp. nov., subgenital plate, female.
12. *P. itoco* sp. nov., subgenital plate, female.
13. *P. motoharui* sp. nov., subgenital plate, female.

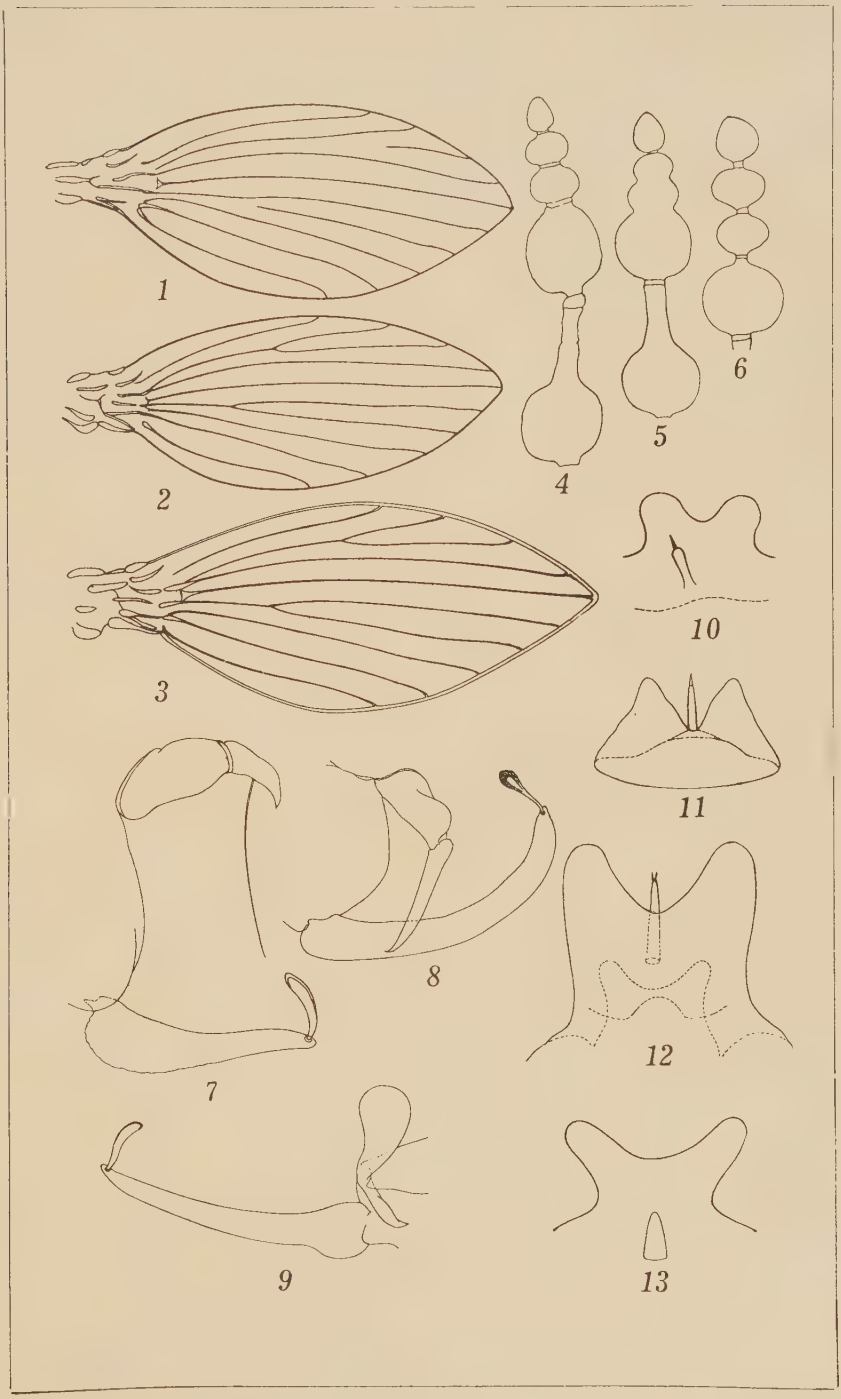


PLATE 1.

A NEW SPECIES OF AMERIANNA FROM THE PHILIPPINES WITH REMARKS ON THE SPIRED PLANORBIDÆ OF THE PACIFIC AREA

By Bengt Hubendick

Riksmuseum, Stockholm 50

ONE PLATE AND ONE TEXT FIGURE

AMERIANNA PESIGANI sp. nov.

The following description is based on two specimens only. Under ordinary circumstances that is a far too small material for creation of a new species. But in this case the form is clearly different from all known species of the area. Further, the two specimens were found in localities on different islands, far from each other.

Material.—Tibak River, Ortega, 7 km west of Palo, Leyte, Philipipnes (=type locality). Leg. by the author July 1, 1952. One specimen.—Borbocolon, 30 km south of Calapan, Mindoro, Philippines. Leg. by the author August 7, 1952. One specimen.

Shell.—The sinistral shell (Plate 1, fig. 1) has four to four and a half fairly slowly increasing whorls. The whorls are convex but the suture is only moderately impressed. The aperture is almost parallel with the axis of the shell. The columella is somewhat reflected but hardly or very slightly twisted. A narrow umbilical chink is present. The species is characterized by hairs, formed of periostracum material, on the surface of the shell (Plate 1, figs. 2–3). They are arranged in rows following the whorl. There are between 20 and 30 such rows at the upper end of the body whorl. Where the hairs are worned off rows of very small, rounded processes are still remaining.

Morphology of the animal.—The tentacles are slender and pointed. The pseudobranch is well-developed. The mantle lobe is hardly projecting. Its two flaps, one frontally and one caudally of the forrowlike, ventral portion of the mantle opening (Plate 1, fig. 4) are bent upwards and inwards. The kidney forms together with the ureter an S-curve. There is no renal ridge but weakly developed dorsal and rectal ridges seem to be present.

The radula (Plate 1, fig. 5) has 23 teeth on either side of the centrals in the examined specimen. The centrals are bicuspid,

the first laterals tricuspid. The marginals have most of their cusps, generally four, along the upper edge and one or two, or none in the extreme marginals, along the lateral edge. The dorsal portion of the jaw has ten strong, vertical bars. The lateral portions of the jaw are weak. The salivary glands are richly lobated and seem to communicate behind the cerebral ring.

The male copulatory organ (Plate 1, figs. 6–7) is simple. There are no special arrangements in the præputium. The penis sheath and the penis are comparatively short. The vas deferens has an almost terminal pore but a very small papilla below the pore is present. The prostate (Plate 1, fig. 8) has a large number of diverticula in all directions from the prostatic portion of the vas deferens. The spermathecal duct is thick and the spermatheca elongate.

The central nervous system is concentrated as in all Planorbidæ but less concentrated than in most of them. There are five ganglia in the visceral commissure, the free pleural ganglia included.

Discussion.—Amerianna is conchologically and anatomically a comparatively heterogenous group. *A. pesigani* differs from other known species of the group in having a well-developed spire. This is a primitive feature. The lack of specializations in the male copulatory organ, if the minute terminal papilla on the penis is disregarded, has also to be regarded as a primitive feature. Specializations in the other parts of the anatomy, which do not occur in other species of *Amerianna,* have not been found.

REMARKS ON THE SPIRED PLANORBIDÆ OF THE PACIFIC AREA

A conchological material of Philippine Planorbidæ comprising several types or paratypes on loan from the Senckenberg Museum in Frankfurt a. M. has been studied by the author. The type of *Ameria hidalgoi* Quadras and Mollendorff [Nachrichtsbl. Malak. Ges. 27 (1895) 120] was of special interest. The examination of the shell led to the conclusion that it may possibly be a species of *Miratesta.* This genus was described by Sarasin and Sarasin (Die Susswasser-Mollusken von Celebes, Wiesbaden, 1898) and is still known only from Celebes. It is of a considerable, not only malacological, but also bio-geographical interest to get full evidence of the representation of the genus in the Philippines. Spiritus material of fresh-water snails from Lake Mainit on Mindanao is much desired.

In 1948, the author published a map [Arkiv fur Zoologi, 40 A (16), p. 59] showing the distribution of *Physastra, Amerianna* and some other groups. Since then more material has been

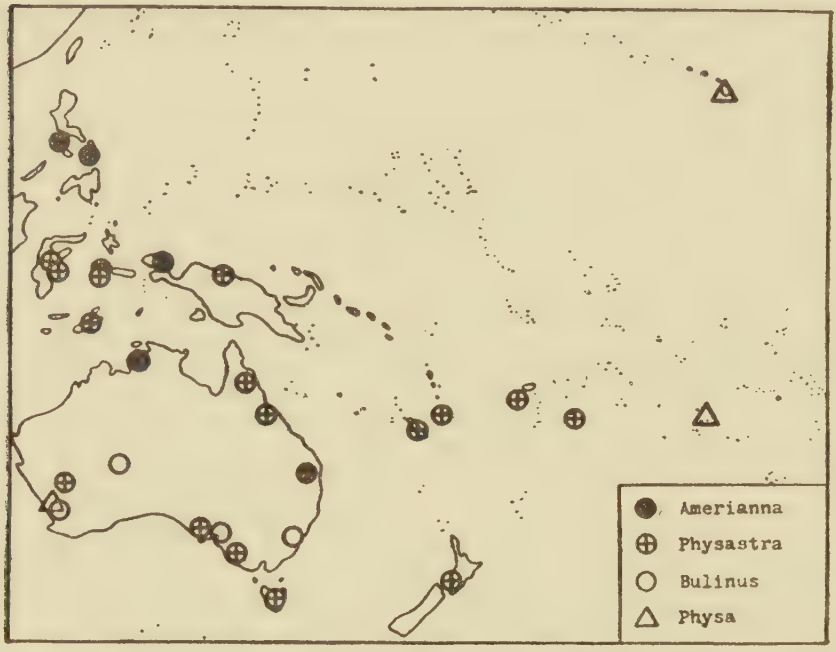


FIG. 1. Map showing the distribution of *Amerianna Physastra* (belonging to subfamily Planorbidæ), *Bulinus* (belonging to subfamily Bulininæ of family Planorbidæ), and *Physa* (belonging to family Physidæ). The map is based exclusively on anatomically examined material.

examined. Besides material collected by the author in the Philippines, material from Bernice P. Bishop Museum in Honolulu and also some material from Queensland collected by Dr. I. D. Hiscock, Brisbane, have been examined. All the material has been anatomically studied and mapped (Fig. 1). The map is not based on any material which is only conchologically determined.

The verified range of *Amerianna* reaches from the Philippines to southeast Queensland and that of *Physastra* from Sumatra (not included in the map) to Fiji and Tonga Islands. *Bulinus* is known from the southern half of Australia only. The main area of this group is located in Africa, the Mediterranean Region and the Near East. No spired Planorbidæ are known from the eastern part of the Pacific. In West Australia, the Hawaiian Islands, and the Cook Islands the same general conchological type is represented by Physidæ. It is not known if these occurrences of physids are original or the result of an artificial introduction.

ILLUSTRATION

Plate 1

Fig. 1. The shell. 6.5.

2. Detail of shell showing arrangement of hairs. 20.

3. Detail of shell showing hairs. 50.

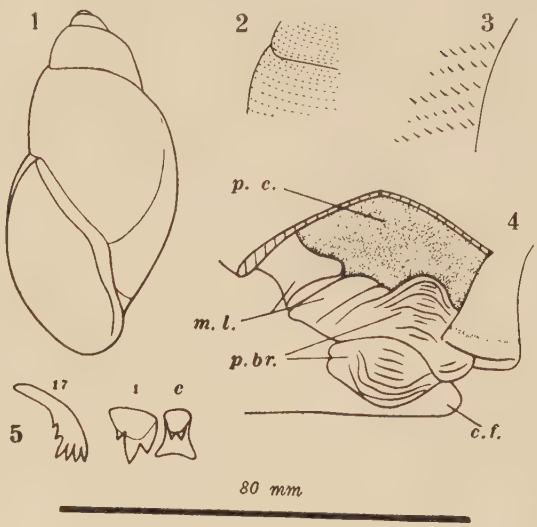
4. The pallial opening and surrounding area. Part of the mantle is cut away. 36. *c. f.*, caudal end of foot; *m.l.*, mantle lobe; *p. br.*, pseudobranch; *p.c.*, pallial cavity.

5. Teeth from the radula. 640. *c.*, central; *l*, first lateral; *17*, marginal from the 17th longitudinal row.

6. Male copulatory organ. 34.

7. Longitudinal section through male copulatory organ. 42.

8. Prostate and female copulatory system, 48. *g.p.*, male genital pore; *m.*, muscle; *m.p.*, muscle pillar; *p.*, penis; *pr.*, prostate; *præ.*, præputium; *p. sh.*, penis sheath; *sp.*, spermatheca; *sp. d.*, spermathecal duct; *u.*, uterus; *v.d.*, vas deferens.



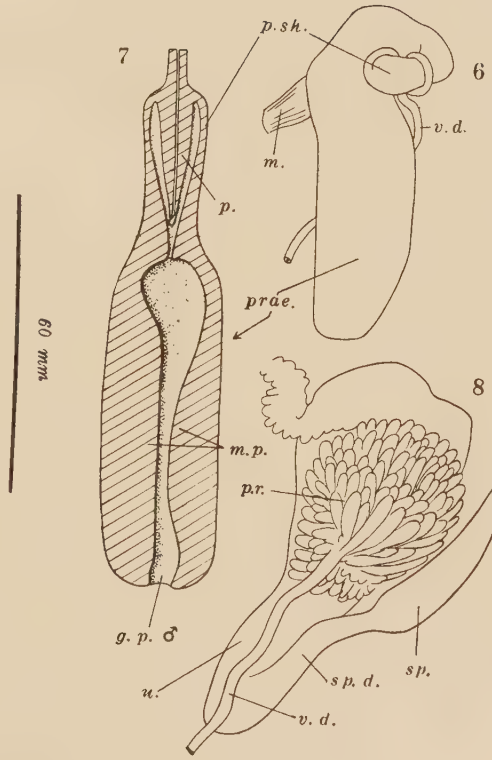


PLATE 1. AMERIANNA PESIGANI sp. nov.

BOOKS

Books received from time to time by the Philippine Journal of Science are reviewed and acknowledged in this section.

General Genetics. By Adrian M. Srb and Ray D. Owen. 1st edition. San Francisco, California, W. H. Freeman & Company, 1952. 561 p. illus. Price, $5.50.

In this book, the authors emphasize the general biological implications of genetics. Attempt is made to present genetics chapter by chapter in terms of hereditary units, in dynamic interplay with environment, on the development and function of organisms. They draw from a wide variety of living forms, ranging from microorganisms through diverse plants and animals to man.

The first sixteen chapters provide elementary genetics covering the so-called "classical" areas of genetics which are usually included in all genetics textbooks. The most important considerations in these classical group are the units of inheritance, alleles, sex chromosomes and sex linkage, chromosomal aberrations and their effects, mutation, extranuclear inheritance, and in breeding and selection.

Chapters 17, 18, and 19 are specially useful for students majoring in a basic biological science. Under the topic Genes and Cellular Biochemistry, the authors have emphasized the molecular basis of phenotype, in other words, genes appear to function by controlling certain biochemical reactions.

The following two chapters, 20 and 21, present population genetics in fair detail, so that selection of materials may be done depending upon their particular need. In these two chapters Mendelian genetics have been extended to patterns of inheritance in population. This is of importance to other branches of biology particularly those dealing with human, agricultural and other natural populations, which differ from the usual laboratory populations of the geneticists involving at the beginning more or less known genetic materials. The application of such a broad knowledge of genetical extension reveals the relationship between various populations as well as their differentiations as affected by migrations, isolation and recombination of the genes. Accordingly, population changes in gene frequency

through migration, random fluctuation, selection, and mutation pressures, are fundamental to evolutionary change.

Chapters 22, 23, and 24, deal with the practical application of genetic principles. Agricultural students would be especially benefited by the information given in Chapters 22 and 23 where practical plant breeding problems are extensively discussed together with the various methods of seed increase or the so-called better seed programs in which not only hybridization and its limitation in plant improvement programs but also the practical utilization of heterosis and also utilization of heterosis and utilization of F_1 hybrids wherein male sterility in the inbred line to be used as female parent in the cross are involved.

Chapter 23 indicates that what is found to be practical with plants may also be of practical value in animal breeding. Pedigree and relatives, individual performance and progeny records and the use of a selection index as possible basis for selecting superior individuals have been well regarded. The improvement of domestic animals is, however, mostly concerned with quantitative inheritance. In this connection, it was made plain that to an animal breeder the two important tools available and could be referred to are selection and control of the mating pattern.

Chapter 24 which deals with the close relation of genetics to man's welfare, gives importance to the inheritance of human traits and the relation between genetics or Engenics and Medicine, or medical genetics; in other words, the utilization of genetic knowledge in the practice of medicine. In a broader sense genetics and races of mankind are well discussed giving the falsity of the superior race concept in man. Results of the studies on the variations within a given so-called race indicate that the genetic principles may be applied to the biological improvement of man. In some countries, programs for achieving some genetic goals not only have been formulated but also to a certain extent are being carried out. The problems of genetics as related to man offer hope of increasing self-understanding and well-being.

The book is sufficiently illustrated besides being provided with a list of valuable and a set of exercises and problems.—J.P.T.

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PUBLICATIONS AVAILABLE

CONTENTS AND INDEX. THE PHILIPPINE JOURNAL OF SCIENCE, vol. 1 (1906) to vol. 10 (1915). Bureau of Science Publication No. 8 (1917). Paper, 442 pages. Price, $4.00 United States currency, postage extra.

SECOND TEN-YEAR INDEX. THE PHILIPPINE JOURNAL OF SCIENCE, vol. 11 (1916) to vol. 28 (1925). Compiled by Winifred I. Kelley. Bureau of Science Monograph 26. Paper, 382 pages. Price, $4.00 United States currency, postage extra.

CHECKLIST OF THE ANTS (HYMENOPTERA: FORMICIDÆ) OF ASIA. By J. W. Chapman and S. R. Capco. Institute of Science and Technology Monograph 1 (1951) new series. Paper, 327 pages. Price, $2.00 United States currency, postage extra.

NOTES ON PHILIPPINE MOSQUITOES, XVI. GENUS TRIPTEROIDES. By F. E. Baisas and Adela Ubaldo-Pagayon. Institute of Science and Technology Monograph 2 (1952) new series. Paper, 198 pages, with 23 plates and 4 text figures. Price, $2.50 United States currency, postage extra.

A REVISION OF THE INDO-MALAYAN FRESH-WATER FISH GENUS RASBORA. By Martin R. Brittan. Institute of Science and Technology Monograph 3 (1953) new series. Paper, 224 pages, with 3 plates and 52 text figures. Price, $2.50 United States currency, postage extra.

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